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Demand and Supply of Agricultural Products in Mainland China

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Executive Summary

This report first presents an analysis of institutional factors and important events in 1994 which may have profound impacts on Mainland China's policies and strategies for agricultural development. For assessing the prospects of agricultural exports in Mainland China, the supply-demand balances were estimated for selected agricultural products in three coastal provinces of Shandong, Jiangsu, and Fujian. The other main tasks include the estimations of supply response and food demand in the coastal region of Shandong, Jiangsu, Fujian and Guangdong.

Even though Mainland China has maintained a substantial growth of agricultural exports during the last 10 years, the foundation of its agricultural policy continues to be based on the substainability of agricultural production to feed its 1.2 billion people. The concerns about the recent serge in grain prices and the national objective of maintaining self-sufficiency in grains will be important factors restricting export growth in the short run.

Analysis of Lester Brown's Prediction

Lester Brown's prediction of a grain deficit of 305 million tons by 2030 plus the high inflation of food stuff in 1994 have stirred heated debates on Mainland China's ability to feed its 1.2 billion people. The renewed emphasis on self-sufficiency in grain will discourage, if not restrict, any attempts to divert grain production to production of high value crops for exports.

For assessing Brown's long-run prediction of Mainland China's grain imports, we undertook a careful review of the available evidence on the income elasticities of grain demand for both rural and urban households. In addition, we also estimated several sets of demand functions for grains and animal products using 1994 provincial data, the observations of food demand without grain rationing which was terminated in May 1993. Overall, the available estimates of income elasticities suggest the growing future needs of grain import by China. However, there exists no basis for predicting such a huge import demand by 2030. In order to conduct a more credible quanttative assessment, we would need to carefully incorporate these estimates of both demand and supply elasticities in a forecasting model and conduct a sensitivity analysis.

Analysis of Supply - Demand Balance

The recent trends of the supply-demand balances show that the coastal region has demonstrated its ability to expand its surpluses of pork, eggs, aquatic products and poultry. However, for food grains including rice, the recent trends of surpluses in Jiangsu and Shandong indicated a weak potential for further export expansion. In Fujian, the balance sheet clearly showed that it has had deficit in grains and the degree of deficits has gotten worse in recent years.

Estimation of Agricultural Supply in the Coastal Region

Agricultural supply response is defined as output and acreage responses. A single commodity supply equation was estimated for three crops and three livestock products, using the 1990 household level survey data in four coastal provinces. Subregional models were estimated using the data from the North (Shandong and Jiangsu) and the South (Fujian and Guangdong) in order to investigate different supply response patterns of crop production in Mainland China's coastal region. The explanatory variables in the supply model include the price of own product, the prices of competing crops, inputs of the factors of production, non farm income, etc. Based on the goodness of fit and the statistical significance of estimated coefficients, the models with county dummy variables performed much better in most of the output and acreage response models, with the exception of output response of grain and oil-bearing crops. In crop acreage response estimation, the Tobit model performed better than the usual ordinary least square (OLS) regression model. Provincial dummy variables were significant in the estimated output response equations of poultry and fresh egg.

When comparing the estimation results, we found that for most agricultural products, the output and acreage responses were quite different across provinces. Among the crops, the output of grain in the northern coastal region was significantly influenced by its own price but not so in the southern region. This finding appears to be reasonable. In the South, rural industry developed faster than in the North, thus, grain production was much less attractive to farmers in the South. The output of oil-bearing crops was found to be barely price responsive, but acreage was highly responsive to its own price and the prices of competing cash crops. Great potential exits to expand the growing area of oil-bearing crops in this region, particularly those high-valued crops, such as sesame and peanut.

With regard to the labor intensive products such as vegetables, we found that the rapid development of rural industry had negative effects on the growing area of vegetables. An in-depth analysis showed that there were different resource constraints between the North and the South. Labor was found to be a major binding constraint in the North, and land availability was the foremost constraint in the South.

As for livestock products, we found that pork supply had a high price elasticity in the whole region, while the price elasticities of poultry and fresh eggs differed notably by region. Fresh egg output was very price elastic in the North, and poultry output was very price elastic in the South. Relating these findings to our analysis of food consumption patterns in the North and South, we found that the differences in price elasticities of poultry and fresh egg supply were partly attributed to the different consumption patterns between the two subregions. Based on these econometric results, the future expansion of livestock supply will critically depend upon the prices of these animal products.

Estimation of Food Demand in the Coastal Region

On the demand side, a Rotterdam demand system was estimated, using pooled time-series (1985-1991) and cross-sectional (four provinces) data from Chinese urban household expenditure surveys. The theoretical properties of this demand system were tested first and then imposed in model estimation. We found that the estimated income and price coefficients were highly sensitive to the imposition of restrictions. The results obtained from imposing both homogeneity and symmetry conditions showed that the marginal budget shares of wheat and rice were negative, implying that they were becoming inferior goods in the urban coastal region. However, rice demand decreased much more slowly than did wheat. Pork, fresh fruits and poultry had the largest expenditure elasticities, indicating that as income increases, urban consumers in the coastal region will allocate more of their budget for these three food groups. Wheat, edible oil, fresh egg, fish and shrimp, and poultry were found to be highly price elastic. Therefore, the future demand of these food items will be determined by their price levels. These estimates should be used with caution because of the government interventions in Chinese agricultural supply market through procurement prices and input prices and in consumption market through rationing on grain and edible oils before 1991. These factors were not captured in the current models.

Implications

The econometric results obtained in this study have important implications for agricultural trade policy in the coastal region. First, grain acreage was found to be unresponsive to price. Thus any further increase in grain output has to rely on increasing yield, which has a limit in the long run. Although the expenditure elasticity for grain was negative in this region, the decreasing rate of grain consumption was very slow, especially for rice. Considering the rapid growth of population and rural industry, there will be a large gap between grain supply and demand in this region.

Second, edible oil consumption had a positive expenditure elasticity, but it was very low, thus imposing little pressure on its domestic supply. Due to the higher price elasticity of acreage response of oil-bearing crops, self-sufficiency in edible oil may be achieved in this region. In addition, high profit oil-bearing crops such as sesame and peanut, may have great potential for export.

Third, as income increases, Chinese urban consumers will consume more meats. Since most meat products come from rural household's backyard, and this production is highly price elastic, a stronger demand for meats will put tremendous pressure on China's domestic livestock industry. Since there is not much potential for increasing grain output in the coastal region, China will need to import substantial amounts of feed grains from the world market and use its abundant labor resource to elevate its livestock industry in the coastal region.

Chapter 1

Introduction

This report documents the research tasks undertaken during the second year of this project. The overall objective of the research project is to assess the future prospects of agricultural trade between Taiwan and Mainland China. During the first year of this project (1993-94), the research team at The Ohio State University analyzed the recent trends of exports and imports of agricultural products in Mainland China (Chern et al., 1994). We also estimated export supply and import demand functions for key agricultural products in Mainland China. It was noted that agricultural exports in Mainland China have increased very rapidly since 1980, especially rice, soybeans, vegetables, peanuts, tea, and aquatic products. The exports of live hogs and pork have had large fluctuations in recent years. Our econometric results of estimating export supply show that domestic production has been a key factor affecting the supplies of major agricultural exports. The relative prices (i.e., between export price and domestic price) were significant only for the export of pork. Our estimation results of import demand also show that domestic production was a key factor in the imports of grains and sugar. These findings suggest that it is essential to understand the supply responses of major agricultural products in order to assess the future agricultural trade in Mainland China.

Based on the findings from the first year, the research focus during the second year has been on development of the econometric models for supply response and demand for agricultural products in Mainland China. Since the coastal provinces are the major exporters and importers of agricultural products, we select Shandong, Jiangsu, Fujian and Guangdong for this study. We analyze first the recent trends of the supply-demand balances of selected agricultural products in these provinces. The subsequent major tasks include econometric estimations of the supply response functions of key agricultural products and the demand for major foods in these provinces. The estimation results were detailed in a M.S. thesis written by Ms. Fang He. Her thesis was submitted to the Council of Agriculture. This report provides a summary of her thesis. The estimated supply and demand elasticities will be used in the forecasting model to be constructed during the third year of this project.

Mainland China's agricultural trade will be affected by the nation's agricultural policy and other closely related macroeconomic policies. It is, therefore, important to understand the recent economic events and government actions which may have profound impacts on the future of agricultural development and trade in Mainland China. An analysis of these recent events is also presented in this report.

It is noted that the publication of Lester Brown's article on "Who Will Feed China" has stirred heated debates within Mainland China about the long-term needs for grain imports. In this report, we also present a careful assessment on the credibility of Brown's prediction from the demand side prospective.

In summary, this report covers the following topics:

(1) An analysis of agricultural policies and institutional factors in Mainland China.

(2) Supply-demand balance of key agricultural commodities in the coastal region.

(3) Econometric estimation of agricultural supply response and food demand in the coastal region.

(4) An assessment of Lester Brown's long-term prediction of Mainland China's grain imports.

(5) Implications for Mainland China's agricultural trade.

Chapter 2

Agricultural Policies and Strategies in Mainland China

Despite the continuing economic reforms in Mainland China, there are institutional factors which have guided Chinese agricultural development. These factors will continue to affect agricultural production and trade in Mainland China. The 1994 was an eventful year for economic planners and scholars in Mainland China. Several events, economic or otherwise, will likely to affect the performance of the agricultural sector for many years to come. In this chapter, we will discuss some institutional peculiarities which have existed in Mainland China. We will also analyze several recent events and their implications.

Disintegration of Agricultural and Trade Policies

The foundation of agricultural policies in Mainland China has been based on sustainability of agricultural production to feed 1.2 billion people. The Ministry of Agriculture is in charge of the production and domestic distribution of agricultural and food products. Agricultural trade is under the jurisdiction of the Ministry of Foreign Trade and Economic Cooperation. As a result, trade has not been taken into consideration in the formation of major agricultural policies in China. It is ironic to observe that agricultural policy makers in Mainland China are ignorant about the implications of China's joining the World Trade Organization (formerly GATT) for agricultural production and marketing. Many of the government interventions such as grain procurement and price supports will not be permitted under the WTO. Furthermore, Mainland China can no longer practice the import licensing for agricultural products. Thus, foreign import competition will likely to emerge in many regions of China, particularly the coastal provinces, after Mainland China joins the WTO.

As for now, Mainland China's agricultural policies are based on the fundamental principle of self-sufficiency in grains. This self-sufficiency objective applies not only to the country as whole, but also to individual provinces. Under such a strategy, the priority in agricultural economy is to produce sufficient staple grains. When the shortage of grains occurred as happened in 1994, the government would pressure farmers, through local officers, to produce more grains. Farmers usually yielded to such pressures despite of the fact that they have been given the freedom to make production decisions under the household responsibility system (HRS). Various forms of government intervention remain widespread in Mainland China.

There has been inconsistencies in policies and programs between the central and local governments regarding agricultural trade. The central government has maintained the key objectives in agriculture as enhancing productivity, maintaining a high self-sufficiency ratio in food, and increasing farm income. The government has been very reluctant to import food and has never made "export" as a goal of developing the agricultural sector. However, in many coastal provinces, such as Fujian and Guangdong, agricultural exports have been a major component in their economic development strategies. In these provinces, they would have pursued a strategy of exporting high-valued agricultural products such as pork, fruits and vegetables, and aquatic products in exchange of importing food grains. Nevertheless, even in these provinces, any aggressive pursuit of promoting agricultural exports has been constrained by the overriding national goal of producing sufficient staple good grains.

Inflation Scare in 1994

In 1994, grain output dropped by 5% from a record high of 456.5 million tons in 1993 and cotton had an acute shortage. Table 1 shows the rates of increases in consumer good prices during 1988-1994. The overall consumer prices at the retail level can be used as a measure of inflation. The inflation rates in China were in double-digit (higher than 10%) in 1988-1989 and relatively low during 1990-1992, but surged to 13% in 1993. In 1994, the overall inflation rate was 22% while the prices of grains increased by more than 48%. It is noted that after the dramatic increases in most food prices in 1988-1989, the overall food prices remained relatively stable for two years (1990-1991) and then started to climb in 1992. Since Chinese urban households spent more than 50% of their income (budget) for food, there was a very high correlation between food prices and the overall inflation rate. In free markets, the prices of major foods such as grains, vegetables, meats, poultry and eggs, fish and shrimp all declined in 1990 and the declining trend was extended for several commodities to 1991 and 1992. However, in 1993 all food prices surged substantially. (No data are available for 1994.)

The rapid increases in grain prices in 1994 might be partially caused by the elimination of grain rationing in May, 1993. There were other macroeconomic factors including financial and exchange rate reforms, which might have contributed to the rising inflation. Nevertheless, the high food prices have forced the government to pay increasing attention to the agricultural sector. Among other things, the central government has

Table 1. Rates of Increase in Consumer Good Prices

Items	Rate of Increase (%) From Previous Year						
	1988	1989	1990	1991	1992	1993	1994
Consumer (Retail) Prices							
All Items	18.5	17.8	2.1	2.9	5.4	13.0	21.7
Food	23.0	16.2	0.3	3.3	7.7	14.3	35.2
Grain	14.1	21.3	-04.8	8.6	24.3	27.7	48.7
Nonstaple Foods	30.4	14.3	1.3	2.4	5.2	14.4	[a]
Clothing	12.7	18.1	7.1	4.1	2.8	6.2	
Free Market Prices	24.2	36.6	-18.6	-13.6	-0.3	16.0	
Grain	18.5	35.4	-4.8	-4.8	-6.1	14.3	
Vegetable Oil	30.1	-0.2	-4.8	2.3	4.0	86	
Vegetables	36.7	13.7	-4.1	-5.0	2.9	13.8	
Meats, Poultry & Eggs	27.9	11.7	-4.6	1.1	3.7	17.9	
Fish & Shrimp	22.2	1.1	-7.8	4.0	-3.6	8.1	
Fruits							

[a] Blanks indicate data not available.

Sources: (1) State Statistical Bureau, Yearbook of China Market Statistics, 1993, and 1994.
(2) State Statistical Bureau, China Statistical Yearbook, 1995.

commissioned task forces to develop long-run strategies to deal with grain supply in China (a topic to be discussed later). It instituted a new responsibility system requiring governors in each province to be in charge of grain supply-demand balance for price stabilization. As a result, many provinces reinstated grain rationing in order to curb the running inflation in staple grains. Under the increasing concerns about the inflation, one can not imagine any government officers would openly push for agricultural exports. This will be an important factor restricting export growth in the short run.

Chapter 3

Supply-Demand Balance

As mentioned previously, China's exports of major agricultural products such as rice and pork were possible due to their surplus in the domestic market. The availability of these products is, therefore, dependent upon the net balance between supply and demand. There exists no published data on the self-sufficiency ratio of food or its components because Mainland China has attempted to maintain a 100% self-sufficiency in food. Since the economic reforms began in 1978, the country has been able to maintain high self-sufficiency ratios except when there were unusual situations of emergency and shortage, requiring imports of food.

Since this study focuses on selected coastal provinces, it is useful to analyze the supply-demand balances of selected agricultural products in this region. The balances can be used as indicators of the potential for interregional and international trade.

Method of Computation

While production data are available for selected agricultural products except vegetables, fruits, and specialty crops, consumption data at the aggregate provincial level are not available. Therefore, we need to estimate total consumption at the provincial level. The computation procedures are as follows. First, we collected population data for rural and urban areas. We then collected the average annual per capita consumption data from the Rural Household Survey and the Urban Household Income and Expenditure Survey conducted by the State Statistical Bureau (SSB). We subsequently computed urban and rural food-use (direct) consumption to obtain the total consumption by province.

In computing the total consumption, we made the following adjustments:

(1) The rural household survey reported grain consumption in raw grain weight. However, the urban household survey reported grain consumption with the refined grain weight. We converted the fine grain to the raw grain by a conversion factor (i.e. the ratio of fine to raw grain) of 0.7 for rice, 0.82 for wheat, and a weighted average for total grain (using rice and wheat consumption in 1994 as weights).

(2) There were no data on the usages of grains for feed and seeds. We made the following approximations:

   (i) For estimating total feed use of grains, we applied the following conversion factors (i.e. the feed grain/meat ratios): beef (3.0), pork (3.3), poultry (1.8), eggs (1.8), and fish (0.5). Using the production figures of these products, we then computed the total feed uses of grains.

   (ii) For seeds, we first computed the average of the seed/production ratio for total grains in Jiangsu province for 1992-94 which was 0.0362 (or 3.62%). This figure was used to compute the seed usage in all three provinces. The seed usages for rice and wheat were not computed and therefore, they are not accounted for in the supply-demand balance computation. Thus, the surpluses of rice and wheat will be somewhat overestimated.

Using the above mentioned adjustments, the balance was then computed as the difference between total production and total consumption. This estimated balance must be interpreted only as a rough approximate for the following additional reasons:

(1) The definition between rural and urban was not the same for population statistics as for the SSB's rural and urban surveys.

(2) The categories of products such as fruits and aquatic products were not exactly the same between reported production and consumption statistics.

(3) Beginning year and ending-year inventories were not reflected in the demand-supply balance computations.

(4) The production estimates were subject to errors.

(5) Total consumption did not account for those used in food processing. For example, grains used for making beer and wine were not included, nor was pork used in making ham or sausages.

Estimation Results

Table 2 shows the rural and urban population in Shandong, Jiangsu, and Fujian. In all three provinces, the shares of urban population have been increasing during this period under economic reforms. Since the food consumption pattern differs significantly between rural and urban households, the migration from rural to urban areas will affect the future supply-demand balances of various agricultural products.

Tables 3-5 present the annual per-capita consumption of selected foods for rural and urban households in these three provinces. Note that there are many missing data. From these consumption data, one can identify several interesting consumption patterns. First, in all three provinces, rural households consumed much more grains but much less pork, eggs, poultry and aquatic products than urban households. The vegetable consumption was very similar between rural and urban areas. Second, the per capita consumption of rice was much larger in Fujian and Jiangsu than in Shandong. In fact, rice accounted for about 85% of grain consumption by urban households in Fujian, while in Shandong it accounted for only 14-16%. Third, grain consumption by urban households has been declining while it has been relatively constant for rural households in all three provinces. Fourth, households in Jiangsu and Fujian consumed much more aquatic products and poultry than those in Shandong. Finally, in recent years, pork consumption has been decreasing in Shandong while increasing in both Jiangsu and Fujian.

Production and estimated consumption figures are presented in Tables 6-8 for the three provinces, respectively. Total grain production in both Jiangsu and Fujian has been very stable during recent years while it showed significant increases in Shandong. With respect to pork production, the increases have been very notable in all three provinces, particularly in Shandong. The growth in the production of eggs, aquatic products and poultry has been very phenomenal in all three provinces. The largest increases in the production of these products registered in 1994. The estimates of total grain consumption show slight increasing trends in recent years, apparently resulting from population increases. Similarly, there have been increasing trends for the estimated consumption of pork, eggs, aquatic products and poultry in all three provinces. Unfortunately, we do not have sufficient data to undertake similar comparison for fruits and other products.

Tables 9-11 show the estimated surpluses or deficits of selected products in the three provinces. Note that the surpluses are likely overestimated because of the exclusion of several consumption categories. Therefore, one can only look at the trend and changing patterns of these surplus figures. In general, the surpluses of grain have fluctuated from year to year in Shandong and Jiangsu. In Jiangsu, the estimated surpluses have been declining. In 1994, the estimated grain surpluses dropped sharply in both Shangdong and Jiangsu. Fujian has had apparent deficits in grains and the degree of deficits have gotten worse in recent years. With respect to pork, the surplus level has been relatively stable at about 0.73 - 0.79 million tons during 1988-93 in Jiangsu while the surpluses have surged in 1994 in Jiangsu and during 1992-94 in Fujian. For eggs and aquatic products, there have been rapidly increasing trends in their surpluses in all three provinces. As for poultry, Shandong and Jiangsu have generated considerable surpluses. However, Fujian appeared to have shortages of poultry.

These recent trends of estimated surpluses and deficits would imply that this coastal region did not show any significant potential for further increases in exports for grain. A similar trend also holds for rice. However, the increasing trends of the surpluses of pork, eggs, aquatic products and poultry would imply a great potential for further increases of the exports of these products in the future (except for poultry in Fujian).

Table 2. **Rural and Urban Population, Selected Coastal Provinces**

(In Millions)

Year	Shandong			Jiangsu			Fujian		
	Rural	Urban	% of Urban	Rural	Urban	% of Urban	Rural	Urban	% of Urban
1978	65.33	6.27	8.8	50.86	7.13	12.3	21.16	3.36	13.7
1979	65.70	6.61	9.1	50.87	7.76	13.2	21.33	3.55	14.3
1980	66.05	6.91	9.5	50.76	8.38	14.2	21.51	3.67	14.6
1981	66.59	7.36	10.0	51.10	8.64	14.5	21.76	3.81	14.9
1982	67.20	7.74	10.3	51.55	8.94	14.8	22.12	3.92	15.1
1983	67.53	8.11	10.7	51.86	9.26	15.2	22.37	4.03	15.3
1984	67.01	9.36	12.3	51.99	9.54	15.5	22.54	4.22	15.8
1985	66.76	10.17	13.2	52.01	9.91	16.0	22.66	4.47	16.5
1986	67.97	9.79	12.6	51.63	10.78	17.3	22.94	4.55	16.5
1987	68.44	10.45	13.2	51.50	11.58	18.4	23.34	4.66	16.7
1988	67.02	13.07	16.3	51.64	12.28	19.2	23.69	4.77	16.8
1989	66.98	14.83	18.1	51.59	13.27	20.5	23.98	4.91	17.0
1990	68.46	15.78	18.7	53.05	14.11	21.0	24.99	5.00	16.9
1991	68.84	16.50	19.3	53.69	14.35	21.1	25.29	5.10	16.8
1992	68.19	17.61	20.5	53.98	14.79	21.5	25.41	5.26	17.1
1993	67.24	18.96	22.0	53.67	15.72	22.7	25.39	5.61	18.1
1994	65.69	20.84	24.1	51.89	16.42	24.0	25.47	5.80	18.5

Source: China Statistical Bureau, China Statistical Yearbook, Various issues.

Table 3. Annual Per Capita Consumption of Selected Foods, Shandong Province

(In kg)

	Grain		Wheat	Rice	Pork		Vegetables	
Year	Rural	Urban	Urban	Urban	Rural	Urban	Rural	Urban
1978	[a]							
1979								
1980	229				5.07[b]		116	
1981		163[c]				15.84[c]		157[c]
1982	216						118	
1983	222	147[c]			6.15[b]	14.40[c]	120	132[c]
1984	231				6.40[b]	14.95[c]	150	142[c]
1985	221	132[c]	46.1[c]	22.5[c]	6.93[b]	14.63[c]	125	153[c]
1986	221	139	51.6	22.4	7.29[b]	15.93	130	139
1987	225	132	50.1	20.0	7.00[b]	15.60	122	133
1988	226	132	59.5	16.0	5.70[b]	12.88	106	129
1989	229	147	65.1	19.8	6.25[b]	18.75	120	161
1990	226	121	59.3	16.2	6.75[b]	14.93	124	115
1991	221	126	65.3	13.9	6.70[b]	14.07	125	114
1992	216	99	70.0	14.0	6.67[b]	12.76	126	119
1993	241.75	79	51.6	14.0	6.51	12.98	105.36	109
1994	250.18	87	58.8	14.3	5.67[b]	12.21	114.50	117

[a]Blanks indicate data not available.
[b]For pork, beef and lamb combined.
[c]For urban city households only (not including townships).

Table 3. (Continued), Shandong Province

(In kg)

Year	Eggs		Aquatic Products		Poultry		Fruits
	Rural	Urban	Rural	Urban	Rural	Urban	Urban
1978	[a]						
1979							
1980	1.24		0.98		0.44		
1981		6.24[c]		7.68[c]		1.44[c]	
1982	2.19				0.39		
1983	2.04	7.92[c]	1.25	6.48[c]	0.44	1.56[c]	
1984	2.41	9.52[c]	1.27	6.55[c]	0.57	1.82[c]	
1985	3.76	12.20[c]	0.93	6.20[c]	0.69	2.22[c]	15.89[c]
1986	3.48	12.33	1.01	7.48	0.66	2.33	17.01
1987	3.92	8.19	1.00	6.76	0.61	1.63	21.81
1988	3.58	9.37	0.91	5.41	0.67	2.37	17.66
1989	3.69	14.37		7.63	0.64	3.36	29.40
1990	3.66	11.20	1.00	5.68	0.69	1.94	21.20
1991	4.54	14.31	1.30	5.83	0.76	2.56	20.68
1992	4.90	16.90	1.58		0.93	3.23	
1993	4.79	15.68	2.26		0.75	3.06	
1994	6.34	17.86	2.41		0.82	3.84	

[a]Blanks indicate data not available.
[b]For pork, beef and lamb combined.
[c]For urban city households only (not including townships).

Table 4. Annual Per Capita Consumption of Selected Foods, Jiangsu Province

(In kg)

	Grain		Rice		Pork		Vegetables	
Year	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
1978	284	155[a]	165	[b]	4.40	11.25[a]	107	115[a]
1979								
1980	295	162[a]	186		6.80	18.00[a]	112	181[a]
1981		147[a]				17.40[a]		136[a]
1982	299				8.30[c]		123	
1983	306	145[a]			9.53[c]	15.48[a]	120	139[a]
1984	311				9.53[c]	17.00[a]	131	133[a]
1985	291	128[a]	202	89[a]	8.98	16.40[a]	116	122[a]
1986	290	132		88	10.57[c]	18.55	123	136
1987	288	136	199	90	9.80	18.07	120	122
1988	291	135	202	89	8.50	17.79	124	130
1989	287	126	201	83	8.95	17.14	136	121
1990	276	119	164	79	9.03	18.49	129	118
1991	282	120	205	80	9.75	19.04	118	115
1992	286	104	216	76	9.90	20.27	127	119
1993	292	98	200	74	10.20	20.43	143	111
1994	268.83	95		71	9.15	18.77	103.42	108

[a]For urban city only (not including townships).
[b]Blanks indicate data not available.
[c]For pork, beef, and lamb combined.

Table 4. (Continued), Jiangsu Province

(In kg)

	Eggs		Aquatic Products		Poultry		Fruits[a]	
Year	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
1978	1.15	[b]	1.40		0.40			
1979								
1980	1.39		1.94		0.80			
1981		5.88[c]		8.64[c]		2.76[c]		
1982	2.37				0.97			
1983	3.05	6.48[c]	2.98	8.40[c]	0.98	3.36[c]		
1984	3.39	7.18[c]	3.00	8.18[c]	1.21	4.10[c]		
1985	4.17	8.98[c]	3.01	9.97[c]	1.56	6.43[c]	2.61	13.05[c]
1986	4.46	8.65	3.92	11.03	1.76	6.56		16.91
1987	4.48	6.72	4.11	10.57	1.66	4.71		17.63
1988	5.26	7.36	3.80	9.73	2.13	6.01	3.46	15.97
1989	6.05	7.08	4.38	10.08	1.96	4.77	3.47	16.83
1990	5.96	7.54	4.92	10.76	1.53	4.35	3.16	17.41
1991	5.96	10.06	5.66	11.20	2.10	5.88	4.04	15.73
1992	7.12	11.64	5.45	12.93	2.32	6.84	4.35	49.49[d]
1993	6.59	10.48	5.89	12.39	2.31	6.22	24.92[d]	44.67[d]
1994	6.76	11.05	6.83		2.65	7.18		

[a]Excluding melons unless otherwise indicated.
[b]Blanks indicate date not available.
[c]For urban city only (not including townships).
[d]Including melons.

Table 5. Annual Per Capita Consumption of Selected Foods, Fujian Province

(In kg)

	Grain		Rice		Pork		Vegetables	
Year	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
1978	[a]							
1979								
1980	292				6.28[b]		137	
1981		135[c]				16.20[c]		92[c]
1982	284				7.38[b]		130	
1983	295	138[c]			8.22[b]	17.16[c]	136	96[c]
1984	302				8.47[b]	17.43[c]	151	
1985	262	138[c]		107[b]	9.81[b]	17.02[c]	133	87[c]
1986	257	139		108	11.03[b]	18.29	123	92
1987	257	138		100	10.71[b]	20.97	114	95
1988	261	139		107	9.96[b]	19.39	112	95
1989	265	141		106	9.76[b]	18.80	113	95
1990	269	134		106	12.17	19.68	137	95
1991	261	126		102	11.23	19.26	153	95
1992	269	142		121	10.80	23.47	129	108
1993	270	138		118	13.99	21.48	109	98
1994	289.24	151		130	13.14	22.86	118.75	102

[a]Blanks indicate data not available.
[b]For pork, beef and lamb combined.
[c]For urban city only (not including townships).

Table 5. (Continued), Fujian Province

(In kg)

	Eggs		Aquatic Products		Poultry		Fruits[a]	
Year	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
1978	[b]							
1979								
1980	0.81		4.77		1.45			
1981		4.56[c]		16.44[c]		1.80[c]		
1982	1.13				1.42			
1983	1.08	5.04[c]	4.09	15.60[c]	1.79	2.76[c]		
1984	1.26	5.91[c]	5.59	11.61[c]	1.76	4.08[c]		
1985	1.24	6.59[c]	3.72	11.07[c]	1.72	4.54[c]		12.68[c]
1986	1.64	6.25	4.33	11.55	2.32	5.21		17.66
1987	1.44	6.47	4.39	11.77	1.99	4.64		20.99
1988	1.68	7.56	4.25	12.04	2.21	5.80		16.14
1989	1.77	7.04		12.50	2.24	4.54		17.91
1990	1.31	6.64	4.20	11.55	2.68	4.29		17.68
1991	1.75	8.60	4.85	11.00	3.13	5.91		23.74
1992	2.18	10.41	4.89	13.49	3.58	8.30	7.23	41.95[d]
1993	2.79	9.32	5.56	16.53	4.18	7.48	9.07	40.51[d]
1994	2.81	9.54	8.36		4.16	8.60		

[a]Excluding melons unless indicated otherwise.
[b]Blanks indicate date not available.
[c]For urban city only (not including townships).
[d]Including melons.

Table 6. **Production and Estimated Consumption of Selected Products, Shandong Province**

(In Million Tons)

Year	Grain				Rice		Pork	
	Production	Estimated Consumption			Production	Estimated Consumption	Production	Estimated Consumption
		Direct	Feed	Seed				
1978	22.9	[a]		0.83				
1979	24.7		2.65	0.89	0.66		0.71	
1980	23.8		3.15	0.86	0.74		0.86	
1981	23.1		3.32	0.84	0.65		0.91	
1982	23.8		3.90	0.86	0.51		0.90	
1983	27.0	16.25	3.94	0.98	0.60		0.87	0.53
1984	30.4		4.87	1.10	0.58		0.97	0.57
1985	31.4	16.10	5.48	1.14	0.63		1.10	0.61
1986	32.5	16.41	5.85	1.17	0.63		1.20	0.65
1987	33.9	16.80	5.89	1.23	0.57		1.16	0.64
1988	32.2	16.89	2.11	1.17	0.48		1.29	0.55
1989	32.5	17.55	7.91	1.18	0.61		1.46	0.70
1990	35.7	17.40	8.69	1.29	0.91		1.54	0.70
1991	39.2	17.30	9.38	1.42	1.12		1.69	0.69
1992	35.9	16.52	11.03	1.30	0.78		1.84	0.68
1993	41.0	18.14	13.28	1.48	0.77		2.03	0.68
1994	39.2	18.70	17.02	1.42	0.81		2.23	0.63

[a]Blanks indicate data not available.

Table 6. (Continued), Shandong Province

(In Million Tons)

Year	Eggs		Aquatic Products		Poultry	
	Production	Estimated Consumption	Production	Estimated Consumption	Production	Estimated Consumption
1978			0.74			
1979			0.63			
1980			0.62			
1981			0.60			
1982	0.34		0.66			
1983	0.41	0.20	0.67	0.14		0.042
1984	0.62	0.25	0.75	0.15	0.100	0.055
1985	0.73	0.38	0.81	0.13	0.084	0.069
1986	0.70	0.36	0.91	0.14	0.098	0.068
1987	0.79	0.35	1.11	0.14	0.127	0.059
1988	1.03	0.36	1.36	0.13	0.187	0.076
1989	1.09	0.46	1.54	0.11	0.205	0.093
1990	1.24	0.43	1.68	0.16	0.300	0.078
1991	1.57	0.55	1.98	0.19		0.095
1992	1.54	0.63	2.53		0.502	0.120
1993	1.92	0.62	3.19		0.853	0.108
1994	2.94	0.79	3.50		1.437	0.134

[a]Blanks indicate data not available.

Table 7. **Production and Estimated Consumption of Selected Products, Jiangsu Province**

(In Million Tons)

Year	Grain				Rice		Pork	
	Production	Estimated Consumption			Production	Estimated Consumption	Production	Estimated Consumption
		Direct	Feed	Seed				
1978	24.0	15.5		0.87	12.8	[a]		0.30
1979	25.7			0.93	13.0			
1980	24.2	16.3	3.65	0.88	11.8		1.04	0.50
1981	25.1		3.40	0.91	13.1		1.03	
1982	28.6		4.98	1.03	14.4		1.22	
1983	30.5	17.2	4.63	1.11	16.1		1.15	0.64
1984	33.5		5.45	1.21	17.5		1.21	0.66
1985	31.3	16.4	6.27	1.13	16.4	11.8	1.36	0.63
1986	33.4	16.4	6.47	1.21	17.0		1.36	0.75
1987	32.6	16.4	6.48	1.18	16.5	11.7	1.29	0.71
1988	32.4	16.7	7.27	1.17	16.6	12.0	1.41	0.66
1989	32.8	16.5	7.26	1.18	17.8	11.9	1.43	0.69
1990	32.6	16.3	7.75	1.18	17.3	10.3	1.49	0.74
1991	30.4	16.9	8.17	1.10	16.5	12.7	1.53	0.79
1992	33.2	17.0	8.85	1.20	17.1	13.3	1.61	0.83
1993	32.8	17.2	9.64	1.19	16.9	12.4	1.66	0.87
1994	30.4	16.0	10.98	1.10	16.0		1.82	0.78

[a]Blanks indicate data not available.

Table 7. (Continued), Jiangsu Province

(In Million Tons)

Year	Eggs		Aquatic Products		Poultry	
	Production	Estimated Consumption	Production	Estimated Consumption	Production	Estimated Consumption
1978			0.40			
1979						
1980			0.43			
1981						
1982	0.26		0.49		0.12	
1983	0.32	0.22		0.23	0.15	0.08
1984	0.48	0.24	0.57	0.23	0.17	0.10
1985	0.61	0.31	0.68	0.26	0.20	0.14
1986	0.66	0.32	0.80	0.32	0.23	0.16
1987	0.69	0.31	0.92	0.33	0.28	0.14
1988	0.79	0.36	1.03	0.32	0.36	0.18
1989	0.79	0.41	1.11	0.36	0.32	0.16
1990	0.90	0.42	1.18	0.41	0.35	0.14
1991	0.98	0.52	1.18	0.46	0.42	0.20
1992	1.12	0.56	1.35	0.49	0.48	0.23
1993	1.32	0.52	1.57	0.51	0.56	0.22
1994	1.55	0.53	1.80		0.71	0.26

[a]Blanks indicate data not available.

Table 8. **Production and Estimated Consumption of Selected Products, Fujian Province**

(In Million Tons)

Year	Grain				Rice		Pork	
	Production	Estimated Consumption			Production	Estimated Consumption	Production	Estimated Consumption
		Direct	Feed	Seed				
1978	7.45	[a]	1.00	0.27	6.19		0.23	
1979	7.85		0.90	0.28	6.49		0.20	
1980	8.02		1.16	0.29	6.69		0.24	
1981	8.10		1.13	0.29	6.81		0.27	
1982	8.48		1.33	0.31	7.16		0.30	
1983	8.58	7.16	1.44	0.32	7.56		0.32	0.25
1984	8.60	6.81	1.75	0.71	7.31		0.37	0.26
1985	7.94	6.55	2.06	0.29	6.81		0.43	0.30
1986	7.52	6.52	2.23	0.27	6.55		0.47	0.34
1987	8.39	6.64	2.47	0.30	7.16		0.51	0.35
1988	8.19	6.87	2.68	0.30	6.88		0.55	0.33
1989	8.85	7.06	2.91	0.32	7.44		0.59	0.33
1990	8.80	7.38	3.07	0.32	7.31		0.63	0.40
1991	8.90	4.25	3.18	0.32	7.26		0.68	0.38
1992	8.97	4.58	3.76	0.32	7.33		0.73	0.40
1993	8.69	7.65	4.22	0.31	6.94		0.81	0.48
1994	8.87	8.58	4.81	0.32	6.99		0.90	0.46

[a]Blanks indicate data not available.

Table 8. (Continued), Fujian Province

(In Million Tons)

Year	Eggs		Aquatic Products		Poultry	
	Production	Estimated Consumption	Production	Estimated Consumption	Production	Estimated Consumption
1978	[a]		0.45			
1979			0.45			
1980	0.036		0.47		0.043	
1981			0.48			
1982	0.043		0.53			
1983	0.046	0.045	0.61	0.15		0.051
1984	0.072	0.053	0.67	0.18	0.037	0.057
1985	0.083	0.057	0.76	0.13	0.052	0.059
1986	0.089	0.066	0.81	0.15	0.058	0.077
1987	0.094	0.064	0.98	0.16	0.069	0.068
1988	0.108	0.076	1.03	0.16	0.085	0.080
1989	0.116	0.077	1.19		0.087	0.076
1990	0.129	0.066	1.19	0.16	0.097	0.088
1991	0.152	0.088	1.35	0.18		0.109
1992	0.171	0.110	1.60	0.20	0.122	0.135
1993	0.193	0.123	1.90	0.23	0.137	0.148
1994	0.230	0.127	2.27		0.161	0.156

[a]Blanks indicate data not available.

Table 9. **Estimated Surpluses of Selected Products, Shandong Province**

(In Million Tons)

Year	Grains	Pork	Eggs	Aquatic Products	Poultry
1978	[a]				
1979					
1980					
1981					
1982					
1983	5.54	0.33	0.21	0.54	
1984		0.40	0.37	0.61	0.04
1985	8.32	0.48	0.35	0.69	0.02
1986	8.72	0.55	0.34	0.77	0.03
1987	9.68	0.47	0.44	0.97	0.07
1988	6.65	0.74	0.67	1.22	0.11
1989	5.32	0.76	0.63		0.11
1990	7.84	0.84	0.82	1.52	0.22
1991	10.55	0.99	1.02	1.80	
1992	6.61	1.16	0.91		0.38
1993	8.09	1.34	1.30		0.74
1994	2.07	1.61	2.15		1.30

[a]Blanks indicate estimates not available.

Table 10. Estimated Surpluses of Selected Products, Jiangsu Province

(In Million Tons)

Year	Grains	Rice	Wheat	Pork	Eggs	Aquatic Products	Poultry
1978	[a]						
1979							
1980				0.54			
1981							
1982							
1983	7.17			0.51	0.10		0.06
1984				0.55	0.23	0.33	0.07
1985	7.08	4.59	4.82	0.73	0.30	0.42	0.06
1986	8.89			0.61	0.33	0.48	0.06
1987	8.04	4.79		0.58	0.38	0.59	0.14
1988	6.82	4.59		0.76	0.43	0.71	0.18
1989	7.41	5.87	4.58	0.74	0.38	0.75	0.15
1990	6.90	7.02	6.50	0.75	0.47	0.77	0.21
1991	3.70	3.83	4.23	0.73	0.47	0.71	0.23
1992	5.75	3.87	7.55	0.77	0.56	0.86	0.25
1993	4.32	4.59	5.63	0.79	0.80	1.06	0.34
1994	2.38			1.03	1.02		0.45

[a]Blanks indicate estimates not available.

Table 11. Estimated Surpluses or Deficits of Selected Products, Fujian Province

(In Million Tons)

Year	Grains	Pork	Eggs	Aquatic Products	Poultry
1978	[a]				
1979					
1980					
1981					
1982					
1983	-0.55	0.07	0.001	0.45	
1984		0.11	0.019	0.49	-0.020
1985	-1.19	0.14	0.025	0.63	-0.007
1986	-1.75	0.14	0.023	0.66	-0.019
1987	-1.27	0.16	0.030	0.82	0.001
1988	-1.91	0.22	0.032	0.87	0.005
1989	-1.71	0.27	0.039	1.13	0.011
1990	-2.24	0.23	0.063	1.02	0.009
1991	-2.11	0.29	0.064	1.18	
1992	-2.99	0.34	0.061	1.41	-0.013
1993	-3.80	0.34	0.070	1.67	-0.011
1994	-4.85	0.44	0.103		0.005

[a]Blanks indicate estimates not available.

Chapter 4

Estimation of Agricultural Supply and Food Demand in the Coastal Region

The coastal region of China includes six provinces and two municipalities. During the reform period, the coastal region has become one of the most important parts of Chinese economy. In 1993, this region accounted for 48.6 percent of China's gross national product. This region is expected to become the growth center of the Chinese economy.

One important benefit of the economic growth in this region is the rapid increase in household income. There have been steady increases in food expenditures and dramatic changes in food consumption patterns. However, the arable land area in the coastal region is very limited, only 0.14 acre per capita in 1993. Rapid industrialization and urbanization are reducing the stock of arable land. From a long-run point of view, this region has the greatest potential of importing agricultural products in China.

As a successful model of market-oriented reform, the economic development pattern in the coastal region may provide a general trend of China's economic development in the future. Thus, understanding agricultural supply response and food consumption patterns in this region may help us forecast more accurately agricultural production and consumption trends for the remainder of China in the years ahead. This understanding is important not only to the Chinese government for the formulation of agricultural trade policy, but also to the agricultural exporting nations in the world.

We focus on four representative provinces in this region: Shandong, Jiangsu, Fujian and Guangdong. This chapter deals with four topics: (1) analysis of historical trends of agricultural production and food consumption patterns during the reform period; (2) the estimation of the agricultural supply response in this region; (3) a complete demand system for analyzing the impacts of changes in prices and income on food demand in urban cities, finally, (4) the implications for agricultural trade in this region

In this study, the coastal region includes four provinces. They are Shandong, Jiangsu, Fujian and Guangdong. Among them, Shandong and Jiangsu are referred to be the North, and Fujian and Guangdong are referred to be the South. Figure 1 shows the location of the four provinces.

Trends of Agricultural Supply: 1979-1993

As a result of rapid development of rural industry, total arable land area in the coastal region has declined quickly During the 1979-93 period, total arable land area declined at 0.72 percent each year. In the south, the rate of decline was greater. For example, in the Guangdong province, the decline in arable land exceeded 2.2 percent per year during the 1979-93 period (Figure 2).

At the same time, the total sown area of grain also decreased. Among the grain crops, the sown area of rice decreased in all four provinces; but the sown area of wheat increased 0.9 percent per year. The sown area of oil-bearing crops trended upward before 1985, but has been declining ever since (Figure 3).

Due to the rapid population growth, the per capita arable land area and the sown area of grains dropped even more quickly. During 1982-93, the per capita arable land area decreased by 2.1 percent annually, and per capita sown grain area decreased by 2 percent per year (Table 12).

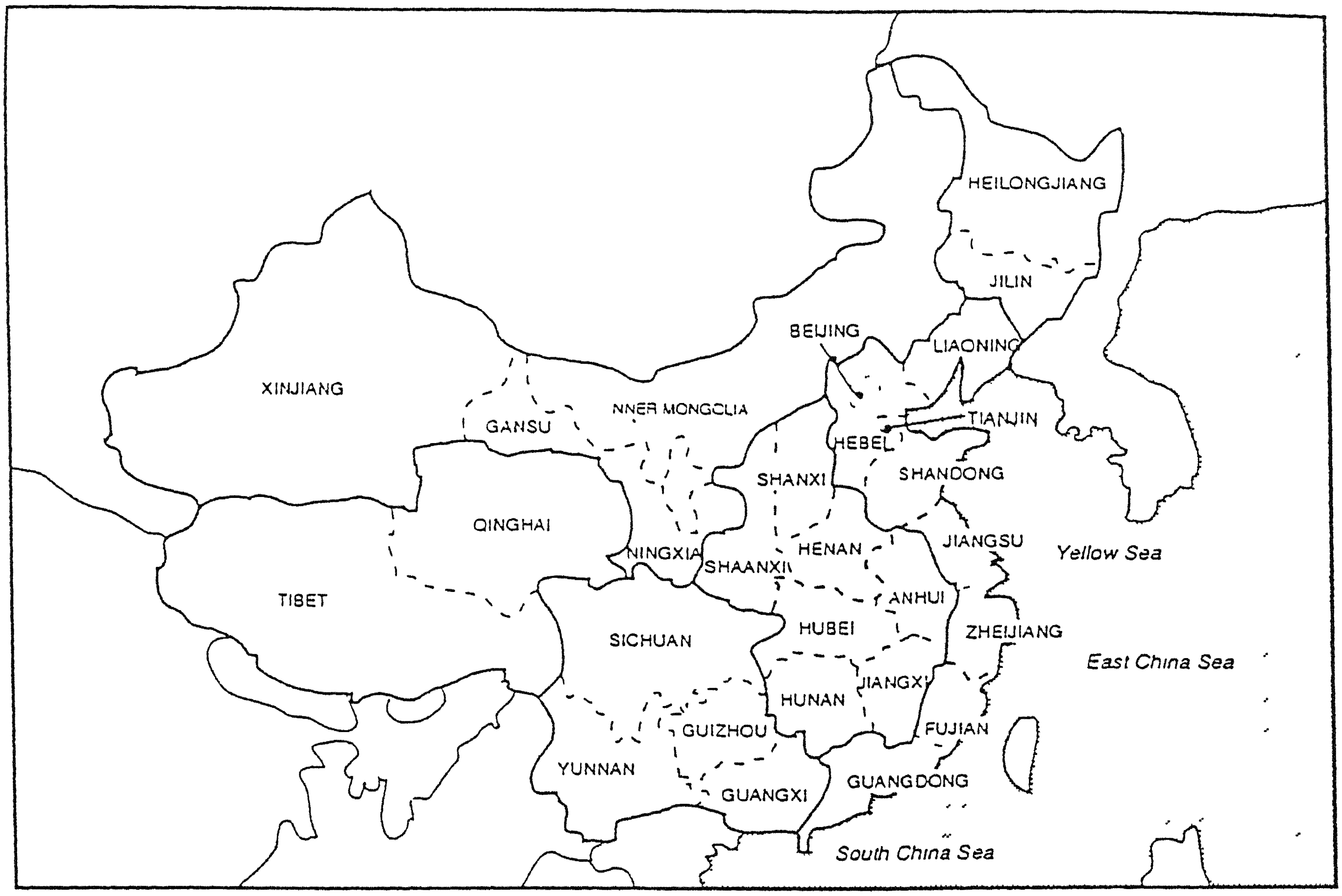

Figure 1. Map of China Showing Region, Subregion, and Province Boundaries.

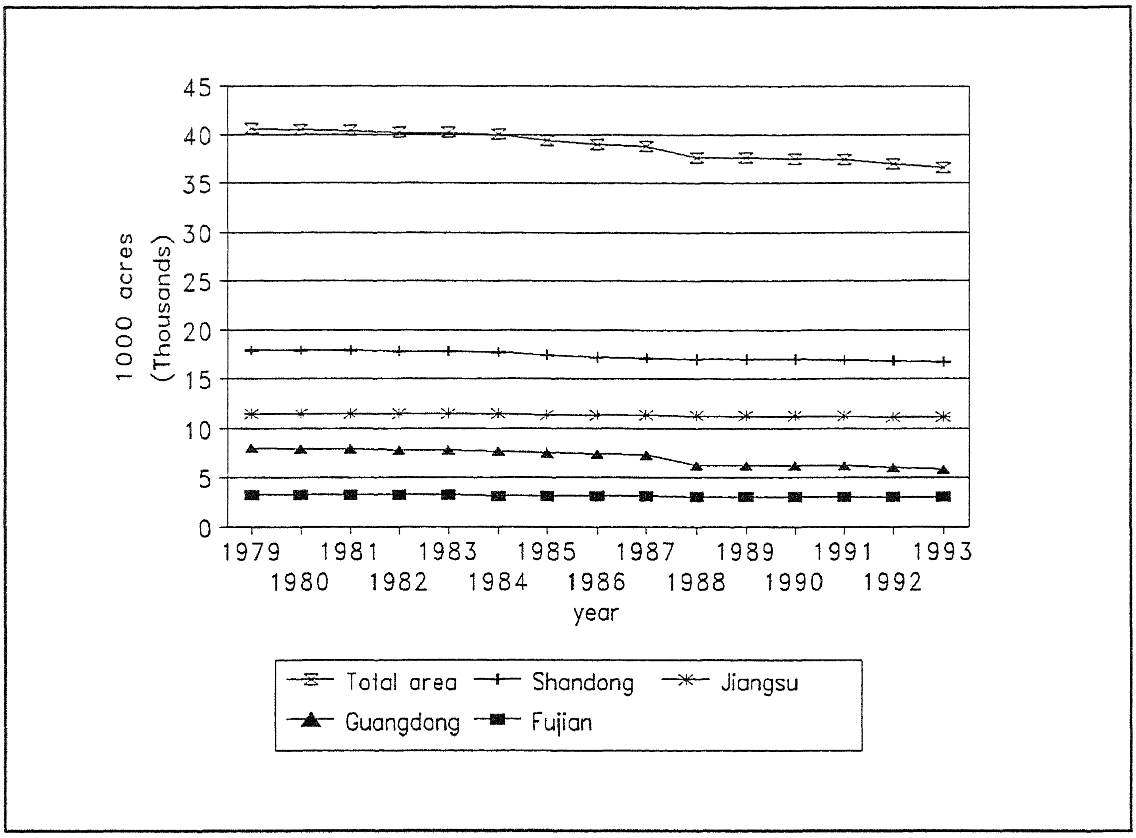

Figure 2. Total Arable Land Area in the Coastal Region: 1979-1993.

Sources: (1) W.H.Colby, F.W.Crook, and S.H.Webb, Agricultural Statistics of the People's Republic of China, 1949-90, Economic Research Service, USDA, Statistical Bulletin No.844, Washington, D.C., December, 1992.
(2) The State Statistical Bureau of China, Statistical Yearbook of China, China Statistical Publishing House, Beijing, 1992, 1993, 1994.

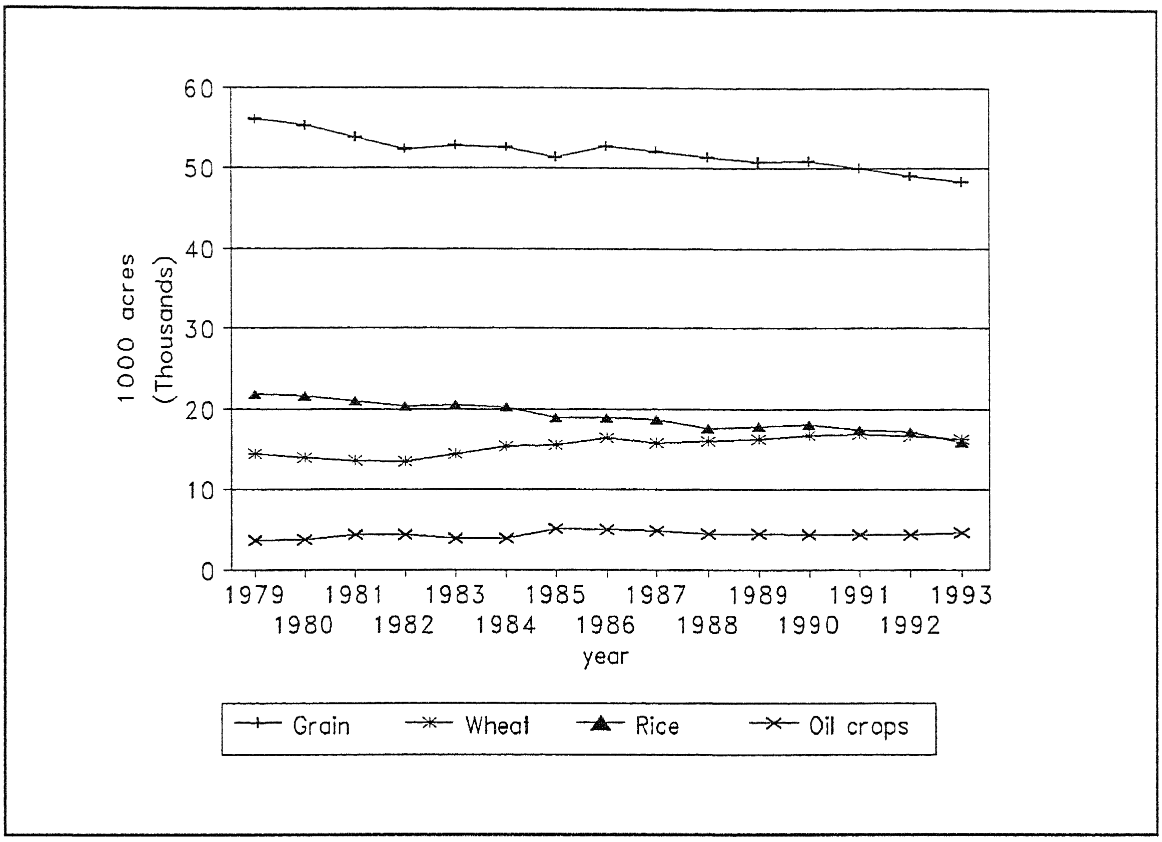

Figure 3. **Total Sown Area of Grain and Oil-bearing Crops in the Coastal Region: 1979-1993.**

Sources: (1) W.H.Colby, F.W.Crook, and S.H.Webb, Agricultural Statistics of the People's Republic of China, 1949-90, Economic Research Service, USDA, Statistical Bulletin No.844, Washington, D.C., December, 1992.
(2) The State Statistical Bureau of China, Statistical Yearbook of China, China Statistical Publishing House, Beijing, 1992, 1993, 1994.

Table 12. Per Capita Sown Area of Grain and Oil-bearing Crops in the Coastal Region: 1982-1993

(unit:acre[a])

Year	Arable Land Area	Grain[b]	Wheat	Rice	Oil-bearing Crops
1982	0.181	0.236	0.060	0.091	0.019
1983	0.179	0.235	0.064	0.091	0.017
1984	0.176	0.231	0.067	0.088	0.016
1985	0.172	0.224	0.067	0.082	0.022
1986	0.168	0.227	0.070	0.081	0.021
1987	0.165	0.221	0.066	0.079	0.020
1988	0.161	0.220	0.068	0.075	0.019
1989	0.159	0.214	0.068	0.075	0.018
1990	0.153	0.208	0.068	0.073	0.017
1991	0.150	0.201	0.067	0.070	0.017
1992	0.147	0.195	0.066	0.068	0.017
1993	0.144	0.190	0.063	0.062	0.018

[a]1 acre=6.07 *mu*, unit used in Chinese statistics.
[b]Grain includes rice, wheat, corn, soybeans and potatoes.

Sources: (1) W.H.Colby, F.W.Crook, and S.H.Webb, Agricultural Statistics of the People's Republic of China, 1949-90, Economic Research Service, USDA, Statistical Bulletin No.844, Washington, D.C., December, 1992.
(2)The State Statistical Bureau of China, Statistical Yearbook of China, China Statistical Publishing House, Beijing, 1992, 1993, 1994.

During 1979-93, total outputs of grain and oil-bearing crops increased by 1.8 and 6.3 percent per year respectively. Among grain crops, wheat output increased by 4.7 percent per year, while rice output declined since 1989 (Figure 4).

The per capita output of grain and oil-bearing crops continued to increase until the mid 1980s, and showed a declining trend since 1985. Table 13 shows the per capita output of grain and oil-bearing crops during this period.

Table 14 shows the changes in the vegetable growing area in the coastal region. Both total and per capita growing area have increased dramatically since 1982. During 1982-93, the total and per capita growing areas increased by 9.4 and 8.6 percent per year, respectively. The two Southern provinces increased faster than the two northern provinces. According to the statistics, the total and per capita vegetable growing areas increased by 11 and 10 percent in the south, with the Fujian province exhibiting an annual growth rate of 13 and 11 percent in terms of total and per capita vegetable growing areas, respectively.

Livestock production in the coastal region has experienced remarkable increases during 1980s. Figures 5, 6, and 7 depict the dramatic increases of pork, poultry meat, and fresh egg output in this region. During 1979-93, the total output in the coastal region increased by one and half times. Shandong, Jiangsu and Guangdong were major pork producing provinces. Their total pork output accounted for 87 percent in the coastal region pork production in 1993. Fujian province, although produced much less, had the highest annual growth rate of 10.3 percent. During 1984-1993, poultry meat output increased by 4.7 times. Guangdong province's increases were 22 percent per year, the highest in this region. During 1982-1993, fresh egg output increased by 4.5 times, and 87 percent of fresh egg output came from the two northern provinces.

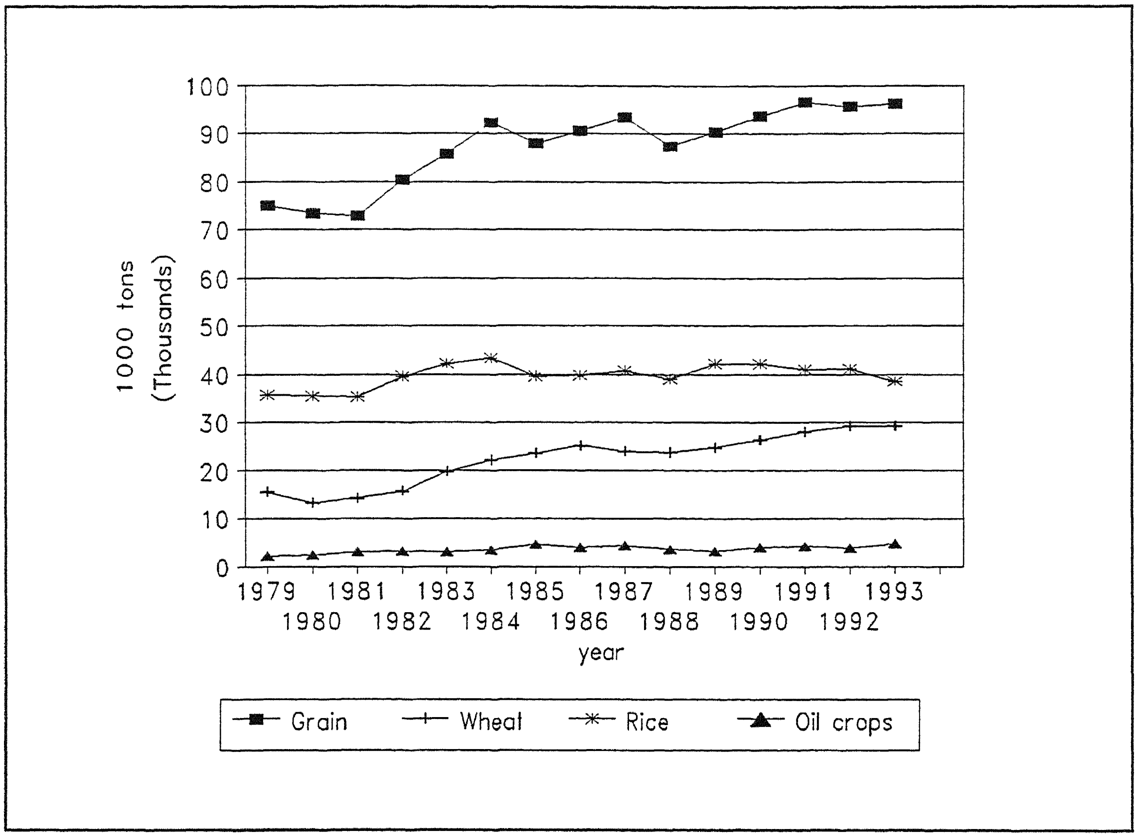

Figure 4. **Total Output of Grain and Oil-bearing Crops in the Coastal Region: 1979-1993.**

Sources (1) W.H.Colby, F.W.Crook, and S.H.Webb, Agricultural Statistics of the People's Republic of China, 1949-90, Economic Research Service, USDA, Statistical Bulletin No.844, Washington, D.C., December, 1992.
(2) The State Statistical Bureau of China, Statistical Yearbook of China, China Statistical Publishing House, Beijing, 1992, 1993, 1994.

Table 13. Per Capita Output of Grain and Oil-bearing Crops in the Coastal Region: 1982-1993

(unit: kg)

Year	Total Grain	Wheat	Rice	Oil-bearing Crops
1982	361.8	70.96	178.1	14.5
1983	382.4	88.2	187.9	13.0
1984	406.9	97.7	191.2	14.3
1985	384.6	102.7	172.4	19.6
1986	391.5	109.2	171.3	17.3
1987	397.6	102.3	173.6	18.2
1988	375.9	101.8	167.8	15.6
1989	382.3	104.6	168.1	13.6
1990	383.2	108.3	172.2	16.3
1991	386.9	111.9	164.0	16.8
1992	379.8	116.1	163.1	14.8
1993	379.5	115.3	151.4	19.0

Sources: (1) W.H.Colby, F.W.Crook, and S.H.Webb, Agricultural Statistics of the People's Republic of China, 1949-90, Economic Research Service, USDA, Statistical Bulletin No.844, Washington, D.C., December, 1992.
(2) The State Statistical Bureau of China, Statistical Yearbook of China, China Statistical Publishing House, Beijing, 1992, 1993, 1994.

Table 14. **Total and Per Capita Vegetable Growing Areas in the Coastal Region: 1982-1993**

Year	Total Area (1000 acre)			Per Capita Area (acre)		
	Coastal Region	North	South	Coastal Region	North	South
1982	1,964	1,178	786	0.008	0.008	0.008
1983	2,075	1,181	894	0.009	0.008	0.009
1984	2,265	1,252	1,013	0.010	0.009	0.011
1985	2,592	1,443	1,149	0.011	0.010	0.012
1986	3,041	1,630	1,411	0.013	0.011	0.015
1987	3,271	1,682	1,588	0.014	0.012	0.017
1988	3,471	1,776	1,695	0.015	0.012	0.019
1989	3,605	1,836	1,769	0.015	0.012	0.019
1990	3,664	1,774	1,890	0.016	0.011	0.020
1991	3,939	1,844	2,095	0.017	0.012	0.022
1992	4,295	2,020	2,275	0.018	0.013	0.023
1993	5,290	2,730	2,560	0.020	0.017	0.023

Source: (1) W.H.Colby, F.W.Crook, and S.H.Webb, Agricultural Statistics of the People's Republic of China, 1949-90, Economic Research Service, USDA, Statistical Bulletin No.844, Washington, D.C., December, 1992.
(2) The State Statistical Bureau of China, Statistical Yearbook of China, China Statistical Publishing House, Beijing, 1992, 1993, 1994.

Table 15 presents the per capita output of pork, poultry meat and fresh egg in the coastal region. During 1982-93, per capita pork and fresh egg output increased by 5.1 and 15.4 percent per year, respectively. The per capita poultry meat output increased by 20 percent per year during 1984-93. In 1993, the Guangdong province ranked first in terms of the per capita pork and poultry meat outputs, and the Shandong province ranked first in terms of per capita fresh egg output.

Trends of Food Consumption in the Coastal Urban Cities: 1985-1991

Due to its geographic and economic advantages, the coastal region benefited greatly from the economic reform. In addition, there were substantial increases in household income and living expenditures. Table 16 shows the general trends of urban household living expenditures during 1985-91. All five broad expenditure categories increased marginally. Among them, the proportion of food expenditure has shown steady increases from 1985 to 1991. During this period, food accounted for 55-60 percent of total living expenditure, which was slightly higher than the national averages (51-54 percent). This trend is similar to that exhibited in the developing and low income nations, where food consumption increases as income increases during the early period of economic development. The expenditure proportions of clothing, daily used articles and other commodities ranged between 8 and 14 percent, and showed a decreasing trend except for the non-commodity category.

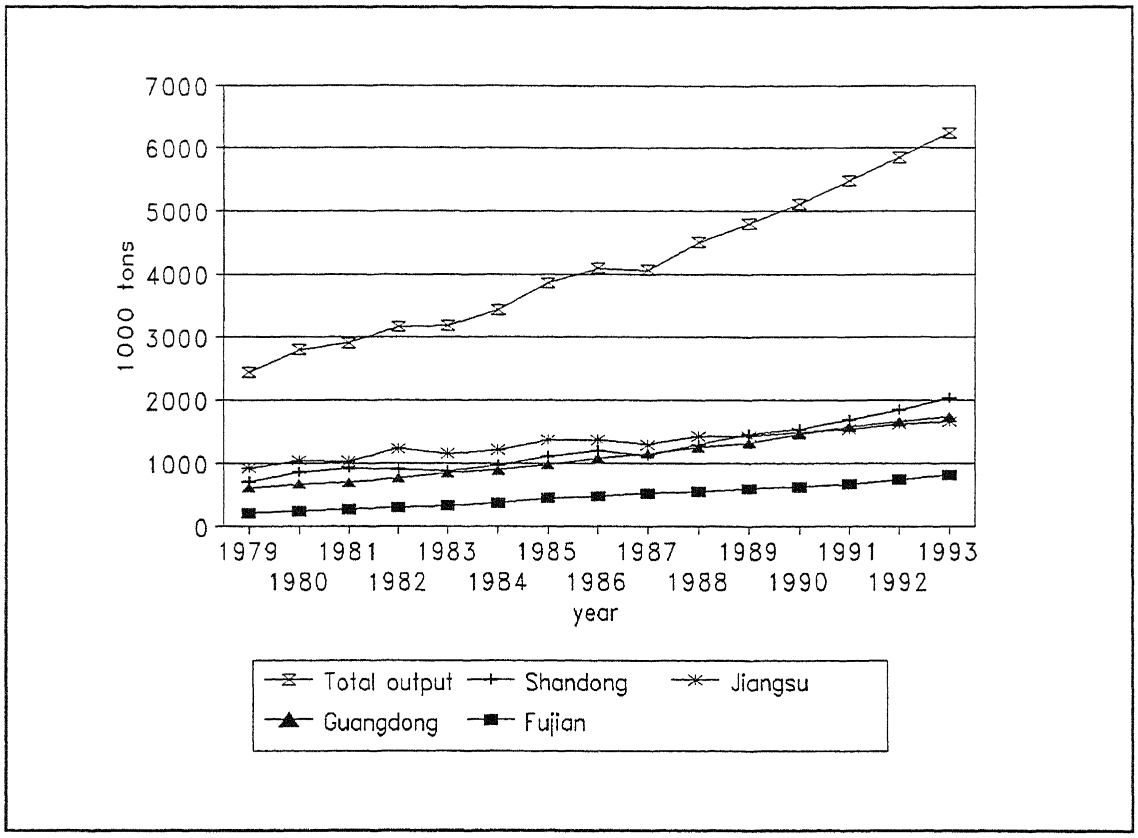

Figure 5. Pork Output in the Coastal Region: 1979-1993.

Sources: (1) W.H.Colby, F.W.Crook, and S.H.Webb, Agricultural Statistics of the People's Republic of China, 1949-90, Economic Research Service, USDA, Statistical Bulletin No.844, Washington, D.C., December, 1992.
(2) The State Statistical Bureau of China, Statistical Yearbook of China, China Statistical Publishing House, Beijing, 1992, 1993, 1994.

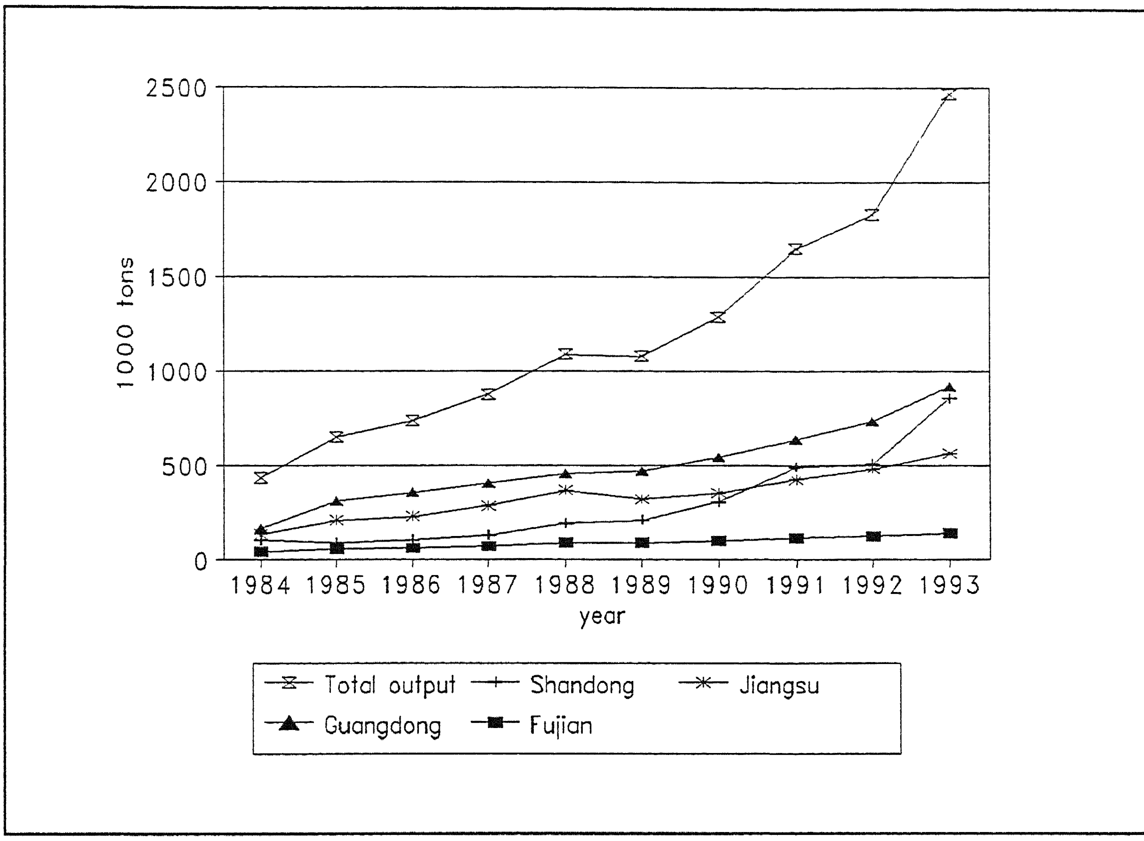

Figure 6. Poultry Meat Output in the Coastal Region: 1984-1993.

Sources: (1) W.H.Colby, F.W.Crook, and S.H.Webb, Agricultural Statistics of the People's Republic of China, 1949-90, Economic Research Service, USDA, Statistical Bulletin No.844, Washington, D.C., December, 1992.
(2) The State Statistical Bureau of China, Statistical Yearbook of China, Rural Statistical Yearbook of China, China Statistical Publishing House, Beijing, 1992, 1993, 1994.

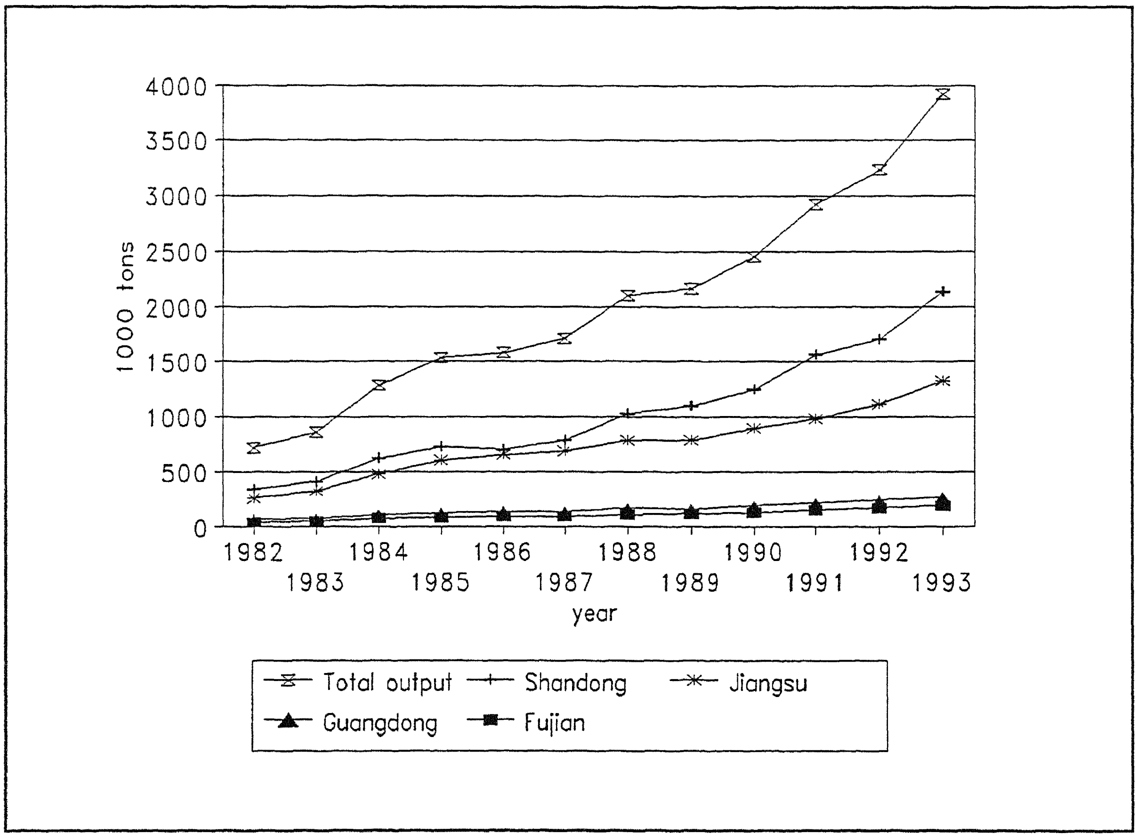

Figure 7. Fresh Egg Output in the Coastal Region: 1982-1993.

Sources: (1) W.H.Colby, F.W.Crook, and S.H.Webb, Agricultural Statistics of the People's Republic of China, 1949-90, Economic Research Service, USDA, Statistical Bulletin No.844, Washington, D.C., December, 1992.
(2) The State Statistical Bureau of China, Statistical Yearbook of China, China Statistical Publishing House, Beijing, 1992, 1993, 1994.

Table 15. Per Capita Livestock Output in the Coastal Region: 1982-1993[a]

(unit: kg)

Year	Pork		Poultry		Fresh Eggs	
	Coastal Region	Guangdong	Coastal Region	Guangdong	Coastal Region	Shandong
1982	14.3	12.7	na	na	3.2	4.6
1983	14.2	13.9	na	na	3.8	5.4
1984	15.2	14.3	1.9	2.7	5.6	8.1
1985	16.9	15.6	2.9	5.0	6.7	9.4
1986	17.7	16.7	3.2	5.6	6.8	9.0
1987	17.2	17.7	3.8	6.3	7.3	10.0
1988	19.4	21.1	4.6	7.0	9.0	12.8
1989	20.3	22.0	4.6	7.8	9.1	13.4
1990	20.9	23.1	5.4	8.6	10.1	14.7
1991	21.9	24.5	6.6	9.8	11.7	18.3
1992	23.3	25.5	7.3	11.2	12.8	19.8
1993	24.6	26.3	9.7	13.9	15.5	24.8

[a]na denotes not available.

Sources: (1) W.H.Colby, F.W.Crook, and S.H.Webb, Agricultural Statistics of the People's Republic of China, 1949-90, Economic Research Service, USDA, Statistical Bulletin No.844, Washington, D.C., December, 1992.
(2) The State Statistical Bureau of China, Statistical Yearbook of China, Rural Statistical Yearbook of China, China Statistical Publishing House, Beijing, 1992, 1993, 1994.

Table 16. Annual Per capita Income and Expenditure of Urban Households in the Coastal Region: 1985-1991[a]

(Unit: Yuan)

Year	Total Income	Total Expenditure	Food	Clothing	Daily used Articles	Other Commodity[b]	Non-Commodity[c]
1985	809.85	760.83	423.45	88.74	90.30	75.18	56.76
1986	997.50	891.60	497.52	102.15	110.55	77.25	70.80
1987	na	1,018.71	574.41	110.04	133.53	85.17	83.91
1988	1,334.58	1,302.18	732.60	137.61	188.37	111.21	102.00
1989	1,561.29	1,546.02	886.41	142.44	188.31	146.37	137.43
1990	1,932.71	1,618.95	938.59	164.73	171.35	136.03	165.22
1991	2,149.18	1,893.36	1,061.99	206.14	202.79	156.48	203.90
Proportion							
1985		100	55.66	11.66	11.87	9.87	7.46
1986		100	55.80	11.46	12.40	8.66	7.94
1987		100	56.39	10.80	13.11	8.36	8.24
1988		100	56.26	10.57	14.47	8.54	7.83
1989		100	57.33	9.21	12.18	9.47	8.89
1990		100	57.98	10.17	10.58	8.40	10.21
1991		100	59.09	10.89	10.71	8.26	10.77

[a]Total income and expenditures are measured in nominal terms. na denotes not available.
[b]Other commodities include cultural related and recreational goods, newspapers, medicine, and fuels.
[c]Non-commodities include rent, utilities and transportation.

Source: The State Statistical Bureau of China, Chinese Urban Household Expenditure Survey, China Statistical Publishing House, Beijing, 1985-1991.

Table 17 shows the long-term trend of major food consumption items on a per capita basis during 1985-91. Per capita grain consumption dropped quickly from 130 kg in 1985 to 117 kg in 1991. Within the food grain category, fine grain consumption decreased greatly. Coarse grain, consumed less frequently in people's diet, increased continuously. As a component of fine grain, rice consumption decreased by 12 kg from 1985 to 1991 but wheat consumption increased by 4 kg during the same period.

All the other food consumption categories showed a marginally increasing trend, especially livestock products and fresh fruits. In terms of annual growth rate, fresh fruit consumption increased by 8 percent, followed by poultry, fresh eggs, and vegetable oils. Pork and seafood (fish and shrimps) are the two major animal products consumed in this region. They together accounted for 70 percent of total meat consumption. The per capita consumption of poultry and fresh eggs changed very little before 1990, but in 1991, they increased rapidly to 7 kg and 10.75 kg, respectively. Among all these food items, the consumption of fresh vegetables showed a decreasing trend during 1985-91.

Table 18 presents the different patterns of food grain consumption in the coastal region. Food grain consumption has declined in both the north and south of the coastal region, but the declining rate in the two southern provinces was greater. In the south, rice has the dominant position. The annual per capita rice consumption was 86-102 kg, which was 70-80 percent of total grain consumption, while wheat accounted for only 3-6 percent of food grain consumption. In the north, both rice and wheat were major food grains. Wheat consumption has increased by 4.3 percent each year, and it accounted for 31 percent of total grain consumption in the north in 1991.

Table 17. Annual Per Capita Food Consumption in the Coastal Urban Cities: 1985-1991

(unit: kg)

Year	Total	Fine Grain	Rice	Wheat	Coarse Grain	Vegetable Oil
1985	130.56	105.24	79.02	15.33	2.97	5.34
1986	132.39	105.81	78.90	15.57	2.79	5.64
1987	128.34	102.51	75.66	16.08	2.76	5.79
1988	130.95	107.01	76.83	18.78	3.03	6.42
1989	129.54	107.91	75.09	22.14	3.36	5.79
1990	124.13	102.31	73.15	18.58	3.59	6.03
1991	117.36	97.06	67.01	19.18	3.37	6.84

	Fresh Vegetables	Pork	Poultry Eggs	Fresh	Fish and Shrimp	Fresh Fruits
1985	115.62	17.58	5.19	8.16	11.22	13.95
1986	120.21	18.57	5.55	8.10	11.91	17.43
1987	114.03	19.38	5.07	7.50	11.76	20.76
1988	117.27	17.82	6.39	8.43	10.95	16.59
1989	117.78	18.21	5.40	8.31	11.85	18.84
1990	113.34	19.19	5.53	8.73	12.43	19.77
1991	108.70	19.28	7.02	10.75	12.24	21.99

Source: The State Statistical Bureau of China, Chinese Urban Household Expenditure Survey, China Statistical Publishing House, Beijing, 1985-1991.

Table 19 reflects the differences in animal products consumption between the north and south. In general, per capita animal product consumption was higher in the south, where pork and seafood were the most commonly consumed animal products. By 1991, the per capita pork and seafood consumption reached 37.4 kg. In the north, pork and fresh eggs were the two major animal products, but poultry and seafood consumption were only half of that consumed in the south.

Table 18. Per Capita Annual Grain Consumption in the Coastal Urban Cities: 1985-1991

(unit: kg)

Year	Total Grain		Rice		Wheat	
	North	South	North	South	North	South
1985	129.9	131.2	55.9	102.2	27.6	3.1
1986	134.0	130.7	57.2	100.6	27.7	3.5
1987	127.7	128.9	53.9	97.4	27.4	4.8
1988	131.9	130.2	53.0	100.6	32.6	4.9
1989	127.9	131.1	50.7	99.5	35.9	4.8
1990	123.3	124.9	49.9	96.3	33.1	4.1
1991	121.4	113.3	47.2	86.8	35.5	2.9

Source: The State Statistical Bureau of China, Chinese Urban Household Expenditure Survey, China Statistical Publishing House, Beijing, 1985-1991.

Table 19. Per Capita Annual Animal Product Consumption in the Coastal Urban Cities: 1985-1991

(unit: kg)

Year	Pork		Poultry		Fresh Egg		Seafood	
	North	South	North	South	North	South	North	South
1985	15.3	19.8	4.3	6.1	10.6	5.7	8.1	14.3
1986	17.0	20.2	4.5	6.6	10.5	5.7	9.2	14.6
1987	16.7	22.0	3.8	6.3	9.4	5.6	7.9	15.7
1988	15.2	20.5	4.9	7.9	10.2	6.7	7.2	14.7
1989	16.3	20.1	3.9	6.9	10.4	6.5	7.9	15.9
1990	17.8	20.8	3.6	7.5	10.7	6.9	8.3	16.6
1991	17.3	21.3	4.7	9.4	13.3	8.1	8.5	16.1

Source: The State Statistical Bureau of China, Chinese Urban Household Expenditure Survey, China Statistical Publishing House, Beijing, 1985-1991.

Theoretical Framework and Empirical Models

The formulation of agricultural supply response developed by Nerlove (1958) is one of the most successful econometric models. His model basically consists of the following three equations (Nerlove, 1958):

$$A_t^* = \alpha_0 + \alpha_1 P_t^* + \mu_t \tag{4.1}$$

$$P_t^* = P_{t-1}^* + \beta (P_{t-1} - P_{t-1}^*) \tag{4.2}$$

$$A_t = A_{t-1} + \theta (A_t^* - A_{t-1}) \tag{4.3}$$

where A_t and A_t^* are actual and desired area under cultivation (or sometimes output or yield) at time t; P_t and P_t^* are actual price and expected price at time t, β and θ are termed to be the expectation and adjustment coefficients. α_0 and α_1 are the parameters to be estimated. The Nerlove model, hypothesizing farmer reactions in terms of price expectations and partial area adjustments, has been adopted and modified by many researchers. Askari and Cummings (1977) summarized some of the frequently used price series: (1) the price of the crop actually received by farmers; (2) the ratio of the price of crop received by farmers to a consumer price index; (3) the ratio of the price of crop received by farmers to an index of the prices of the inputs; (4) the ratio of the price of the crop received by farmers to an index of the prices of competitive crops. Norlove's formulation provides a basis for specifying the empirical model used in this study.

<u>Empirical Model of Agricultural Supply Response in China</u>

In order to analyze the differences in agricultural production between the north and the south of the coastal region, the output and acreage response functions of crops are estimated for the north and the south separately. The empirical models for agricultural supply response consist of the following four parts:

(1) Grain Output and Acreage Response Functions:

Output model:

$$LnY = \alpha + \beta_1 Ln\ P + \beta_2 Ln\ A + \beta_3 Ln\ F \tag{4.4}$$

where Y = total output of grain,

P = price of grain,

A = grain sown area,

F = amount of chemical fertilizer used.

Acreage model:

$$\begin{aligned} Ln\ A = \alpha + \beta_1 Ln\ P + \beta_2 Ln\ P_{cot} + \beta_3 Ln\ P_{oil} \\ + \beta_4 Ln\ P_{veg} + \beta_5 Ln\ L + \sum \gamma_k D_k \end{aligned} \tag{4.5}$$

where A = growing area of grain,

P = price of grain,

P_{cot} = price of cotton,

P_{oil} = price of oil-bearing crops,

P_{veg} = price of vegetable,

L = total arable land area,

D_k = dummy variable for county k.

The output function is specified as a function conditional upon acreage. So this function captures the changes in yield. In fact, one can substitute Eq.(4.5) into Eq.(4.4) to obtain an unconditional output function. The yield response is not estimated due to insufficient information on climate and soil condition.

(2) Supply Response Functions of Oil-bearing Crops:

Output model:

$$Ln\ Y = \alpha + \beta_1 Ln\ P + \beta_2 Ln\ A + \beta_3 Ln\ LA \tag{4.6}$$

where Y = total output of oil-bearing crops,

P = price of oil-bearing crops,

A = growing area of oil-bearing crops,

LA = number of agricultural labor force.

Acreage model:

$$Ln\ A = \alpha + \beta_1 Ln\ P + \beta_2 Ln\ P_j + \beta_3 Ln\ L + \Sigma\gamma_k\ D_k \tag{4.7}$$

where A = growing area of oil-bearing crops,

P = price of oil-bearing crops,

P_j = price of competing crops, j represents cotton in the north, and sugar in the south,

L and D_k are defined as earlier.

(3) Vegetable Supply Response Functions:

Output model:

$$Ln\ Y = \alpha + \beta_1 Ln\ P + \beta_2 Ln\ A + \beta_3 Ln\ F \tag{4.8}$$

where Y = total output of vegetable,

P = price of vegetable,

A = growing area of vegetable,

F = usage of chemical fertilizer.

Acreage model:

$$Ln\ A = \alpha + \beta_1 Ln\ P + \beta_2 Ln\ L + \beta_3 Ln\ LA + \beta_4\ NFI + \Sigma\gamma_k D_k \qquad (4.9)$$

where A = growing area of vegetables,

P = price of vegetables,

NFI = proportion of non-farm income,

L, LA and D_k are defined as earlier.

(4) Livestock Output Response Models for Pork, Poultry and Fresh Eggs:

$$Ln\ Y_i = \alpha + \beta_1 Ln\ P_i + \beta_2 Ln\ E + \Sigma\beta_j Ln\ P_j + \Sigma\gamma_k D_k \qquad (4.10)$$

where Y_i = total output of livestock product i , i=1, 2, 3 for pork, poultry and fresh eggs, respectively,

P_i = price of product i,

P_j = price of competing livestock products,

E = household expenditures on livestock raising,

D_k = dummy variable for province k, k=1, 2, and 3 for Jiangsu, Fujian and Shandong, respectively.

Based on above double-log specifications, the own-price elasticity of supply can be obtained directly from the estimated own-price coefficient.

Theoretical Framework of Consumer Demand Analysis

The consumer's basic problem is to allocate expenditures among different commodities, given prices and income. The classical consumer demand model is based on the consumer's utility maximization subject to the budget constraint, i.e.,

$$Max\ U = U(q_1,\ q_2,\ \ldots,\ q_n) \tag{4.11}$$

$$s.t. \quad \sum p_i q_i = E$$

where U is the utility function reflecting consumer's preferences, q_i's are quantities in the consumer choice bundle, p_i's are the prices corresponding to the commodity set, and E is consumer's total expenditure. The solutions to this maximization problem give the Marshallian demand equations which can be written explicitly as:

$$q_i = q_i\ (P_1,\ p_2,\ \ldots,\ p_n,\ E) \tag{4.12}$$

The Rotterdam demand model, developed by Barten (1964) and Theil (1965), is based on a first order approximation to the demand system. Taking the differential of the logarithm of Eq.(4.12), we obtain:

$$d\ \log\ q_i = \frac{\partial\ \log\ q_i}{\partial\ \log\ E}\ d\ \log\ E + \sum_j \frac{\partial\ \log\ q_i}{\partial\ \log\ p_j}\ d\ \log\ p_j \tag{4.13}$$

The derivations on the right-hand side are the income and Marshallian (or uncompensated) price elasticities. Let us define them as e_i and e_{ij}, respectively and use the Slutsky decomposition to write $e_{ij} = e^*_{ij} - e_i w_j$, for Hicksian (or compensated) cross price elasticity e^*_{ij}, so that Eq. (4.13) becomes:

$$d \log q_i = e_i\ (\log E - \Sigma w_k\ d \log p_k\ ) + \Sigma_j e^*_{ij}\ d \log p_j \qquad (4.14)$$

Multiplying Eq. (4.14) by the budget share w_i results in the Rotterdam model:

$$w_i\ d \log q_i = \theta_i\ (d \log E - \Sigma_j w_j\ d \log p_j\ ) + \Sigma \pi_{ij}\ d \log p_j \qquad (4.15)$$

Equation (4.15) represents Hicksian demand. In order to implement Eq.(4.15), it is necessary to consider a finite approximation and assume θ_i and π_{ij} are constant. The estimable version of the Rotterdam model proposed by Theil (1965) is :

$$w^* D(q_{it}) = \theta_i\ DQ + \Sigma_j\ \pi_{ij}\ DP_{jt} + \mu_{it} \qquad (4.16)$$

where $W^*=(W_{it}+W_{i,t-1})/2$, $DQ=\Sigma W_{it} D(q_{it})$, D is the log-change operator, i.e., $D(Z_t)=Log(Z_t/Z_{t-1})$, and u_{it} is a random error term with the following properties:

$$E\ (\ \mu_{it}\ ) = 0, \qquad (4.17)$$

$$E\ (\ \mu_{it}\ \mu_{js}\ ) = \omega_{ij} \quad if \quad s=t, \qquad (4.18)$$

$$E\ (\ \mu_{it}\ \mu_{js}\ ) = 0 \quad if \quad s \neq t. \qquad (4.19)$$

The properties of demand functions can be satisfied with the following parameter restrictions in the demand system:

$$\textit{Adding-up:} \qquad \Sigma\, \theta_i = 1, \quad \Sigma_i\, \pi_{ij} = 0, \tag{4.20}$$

$$\textit{Homogeneity:} \qquad \Sigma_j\, \pi_{ij} = 0, \tag{4.21}$$

$$\textit{Symmetry:} \qquad \Sigma\, \pi_{ij} = \Sigma\, \pi_{ji}\ . \tag{4.22}$$

The income and price elasticities of demand can be expressed in terms of parameters as:

$$\textit{Income Elasticity:} \qquad E_i = \frac{\theta_i}{w_i} \tag{4.23}$$

$$\textit{Compensated Price Elasticities:} \qquad s^*_{ij} = \frac{\pi_{ij}}{w_i} \tag{4.24}$$

$$\textit{Uncompensated Price Elasticities:} \quad e_{ij} = s^*_{ij} - e_i\, w_j \tag{4.25}$$

A commodity is estimated to be inferior if $\theta_i<0$, $e_i<0$; or to be non-inferior if $\theta_i\geq0$, $e_i\geq0$; Substitute and Complements can be defined in terms of the sign of π_{ij}. If π_{ij} is positive, good i and good j are substitutes; If π_{ij} is negative, they are complements.

Data and Estimation Procedures

Agricultural Supply Response Analysis

Unlike many previous studies, this study makes use of the household data obtained from Chinese rural household survey before they are aggregated to provincial level. The

Chinese rural household survey is conducted by the General Organization for Rural Household Survey of the State Statistical Bureau. The survey started in 1955, was suspended during 1966-1977, and was resumed in 1978. The sample for 1990 survey included 66,960 households in 28 provinces, autonomous regions and municipalities.

The rural household survey covers the following nine broad areas: (1) Basic information of the rural household. (2) household production of various crops, livestock and forestry products. (3) household selling of crops, livestock and forestry products. (4) household balance of grain. (5) total and net revenue of the household. (6) household total expenditures. (7) household cash balance. (8) household commodity expenditures, and (9) household consumption. In this survey, grain refers to cereal crops (including rice, wheat, corn, sorghum, etc.), potatoes and beans (including soybean, broad bean, pea, etc.). Oil-bearing crops include peanut, sesame, rapeseed, sunflower. Fresh vegetables are the sum of all varieties.

For the purpose of this study, we used the data from four coastal provinces: Jiangsu, Shandong, Fujian and Guangdong. The data set includes 13 counties, 140 villages and 1,190 households. Table 20 briefly summarizes the household production in the four provinces. Besides grain, fresh vegetable and oil-bearing crops are two major products in this region. In Jiangsu and Fujian, 90 percent of rural households grow fresh vegetables. Cotton is produced only in the two northern provinces, and sugar is produced only in the south. There are more households who raise swine and poultry in the south than those in the north.

Using household data raises the problem of limited dependent variable. Therefore, the household data are first aggregated to the village level, and then divided by the number of households in each village, generating the average household production in each village. These procedures greatly reduced the number of observations with zero output of particular products. Therefore, there are 140 observations, representing 140 villages.

As pointed out earlier, the agricultural supply response analysis in China involves estimating both output response and growing area response. In addition, the regional differences make it necessary to estimate the output and area models in the north and south separately. We have 74 villages in the north and 66 in the south. However, the livestock output models are estimated for the whole region.

Price data is calculated by dividing the sale revenue by quantity. For those villages that had zero revenues and sale quantities of certain products, the following procedures were taken to avoid missing price value. First, the average price of the county where those villages were located was used as a proxy. Second, if the county also had zero sale revenue and quantity of that particular product, the average price of the province where the county is located was used as a proxy.

Even though the data were first aggregated at the village level, there are still zero output for certain products, generating zero value of dependent variable, especially for oil-bearing crops. It was Tobin (1958) who made the first contribution to the literature on estimating functions in which the dependent variable takes the above form. In this study, a very small number (0.0001) is used to replace zero when Ordinary Least Square (OLS) is used to estimate all the equations. Tobit model is used to estimate the acreage response in order to obtain consistent estimates.

Table 20. Proportions of Households which Produce the Following Products in the Coastal Region

Products	North		South	
	Jiangsu	Shandong	Fujian	Guangdong
		---- percent----		
Grain	100	98	89	99
Cotton	20	52	0	0
Oil-bearing Crops	60	30	31	77
Sugar	0	0	20	25
Fresh Vegetable	90	78	90	100
Pork	57	60	70	74
Poultry	62	60	84	99
Fresh Egg	97	78	30	82
Number of Households in the Sample	340	400	210	240

Source: The State Statistical Bureau of China, Chinese Rural Household Survey, 1990.

Food Demand

The income, expenditure and consumption data used in this study are from the surveys of urban households. The data are published in *Income and Expenditure Survey of Chinese Urban Households* compiled by The State Statistical Bureau of China from 1985 to 1991.

The sample survey of urban households is conducted by the General Organization for Urban Household Survey of the State Statistical Bureau. It started in 1956, but was suspended during the period 1966-1979 and resumed in 1980 (He, 1985). Urban households are defined as those as having staff and workers in the state and collective institutions. Sample households are selected using the three-stage stratified and systematic sampling techniques. Cities are selected in the first stage, enterprise and institutions are selected in the second stage and households are selected in the third stage (Taylor and Hardee, 1986).

The present study uses data for seven years from 1985 to 1991. All income and expenditure data are in nominal terms. The prices of the food commodities are obtained by dividing the expenditure on each food by quantity purchased. The commodity classification is as follows: 1, wheat; 2, rice; 3, vegetable oils; 4, fresh vegetables; 5, pork; 6, beef and mutton; 7, poultry; 8, fresh eggs; 9, fish and shrimp; and 10, fresh fruit.

The model in Eq.(4.15) is referred to as seemingly unrelated regression models, so it is fitted to the pooled time-series and cross-sectional data of food consumption by Zeller's iterative estimation procedures. The adding-up restriction is satisfied automatically since the budget shares add up to 1. The homogeneity and symmetry conditions are tested with the data and imposed on the parameters of the demand model.

The Iterative Seemingly Unrelated Regression (ITSUR) is used to estimate the demand system. Formally, we have ten demand equations. However, only nine of them are independent. Therefore, we leave out the 10th equation since all the information is contained in the other nine equations. Barten (1964) showed that it makes no difference which equation is left out as long as the iterative estimation procedure is employed.

Estimation Results of Agricultural Supply Response

<u>Supply Response of Grain</u>

Table 21 presents the econometric results of grain output and acreage response functions in the northern coastal region. The R^2's of both output and acreage models range between 0.74 and 0.79, showing the overall goodness of fit of the models as satisfactory.

In the output model (column 1), the high R^2's and statistical significance indicate that the household grain output in the northern coastal region can be explained by grain price, growing area, and the usage of chemical fertilizer. The own-price elasticity of grain output is 0.53. Columns 2 through 4 show the results of sown grain area models estimated with and without county dummy variables. The results show that the grain growing area is highly related to the household land area. All the own-price effects are positive but not statistically significant.

With one exception (cotton price), all cross-price effects are negative, showing the competing nature of grain and other cash crops. The positive sign of cotton price in all three area models is consistent with the situation in China. Grain and cotton are two basic agricultural products affecting the basic subsistence of Chinese people, therefore, the government has a tight control on their production by economic and administrative measures. An increase in the price of one crop is usually accompanied by a similar price increase in the other. The results also show that the inclusion of county dummy variables helps little in terms of improving R^2's and t-ratios. A comparison between columns 2 and 4 reveals that the Tobit model outperforms the OLS model in which a zero value of the dependent variable is replaced by a very small number.

Table 21. Estimates of Grain Output and Acreage Response in the Northern Coastal Region[a]

Explanatory	Output	Acreage		
Variables	OLS	OLS-(1)	OLS-(2)	TOBIT
Intercept	6.04**	-1.83	-1.48**	-1.55
	(16.89)	(-1.18)	(-2.06)	(-1.49)
$Ln(P_{grain})$	0.53**	0.45	0.32	0.33
	(2.37)	(1.11)	(1.05)	(1.57)
$Ln(P_{cotton})$		1.20	0.95**	1.26**
		(1.47)	(3.17)	(2.30)
$Ln(P_{oil})$		-0.11	-0.15	-0.15
		(-0.62)	(-0.99)	(-1.21)
$Ln(P_{vegetable})$		-0.07	-0.13*	-0.04
		(-0.82)	(-1.74)	(-0.67)
Ln(Fertilizer)	0.11*			
	(1.71)			
Ln(Sown area)	0.64**			
	(9.51)			
Ln(Land)		1.06**	1.03**	0.87**
		(9.99)	(12.38)	(12.96)
D1		-0.22		-0.24
		(-0.84)		(-1.47)
D2		-0.14		-0.24
		(-0.52)		(-1.46)
D3		-0.12		-0.18
		(-0.44)		(-1.02)
D4		0.03		0.09
		(0.14)		(0.80)
D5		-0.08		0.18*
		(-0.50)		(1.65)
D6		-0.17		-0.1
		(-0.88)		(-0.75)
R^2	0.79	0.74	0.74	

[a]Numbers in parentheses are t-ratios.
** denotes significance at 5% level or better, * denotes significance at 10% level.

Table 22 summarizes the econometric results of grain output and acreage response functions in the southern coastal region. In the output model, the own-price elasticity of grain supply is 0.18, and it is not statistically significant. In the acreage models, (columns 2 through 4), the Tobit model performs almost the same as the other ones. The statistical significance of the county dummy variables show that there exist differences in the area supply response across those counties in the southern coastal region. In the models with dummy variables, all the cross-price effects are negative, except for oil-bearing crops. This result can be explained by the particular situation in China. Most commodity grain and oil-bearing crops are purchased by government, and the government usually increases the procurement prices of grain and oil-bearing crops simultaneously. Thus, even though the price of oil-bearing crops increases, farmers may grow more grain if grain production has a higher profit.

Both output and acreage models imply that grain price has almost no effect on grain production in the south. This finding can be explained in part by the rapid development of rural industry in this region, especially in the Guangdong province.

Table 22. Estimates of Grain Output and Acreage Response in the Southern Coastal Region[a]

Explanatory	Output	Acreage		
Variables	OLS	OLS-(1)	OLS-(2)	TOBIT
Intercept	3.69**	-2.16	2.03	-0.60
	(4.75)	(-0.78)	(0.84)	(-0.47)
$Ln(P_{grain})$	0.18	0.50	0.12	0.16
	(0.59)	(1.32)	(0.27)	(0.80)
$Ln(P_{sugar})$		-0.70	2.21*	-0.47
		(-0.53)	(1.76)	(-0.77)
$Ln(P_{oil})$		1.56	1.56**	0.66
		(1.24)	(3.59)	(0.95)
$Ln(P_{vegetable})$		-0.17	-0.30	-0.04
		(-0.75)	(-1.11)	(-0.40)
Ln(Fertilizer)	0.22*			
	(1.75)			
Ln(Sown area)	1.55**			
	(18.45)			
Ln(Land)		1.46**	1.46**	1.04**
		(7.87)	(6.77)	(9.16)
D1		-1.46		-0.83
		(-1.26)		(-1.30)
D2		-2.08**		-1.15**
		(-4.80)		(-4.80)
D3		-0.58		-0.35
		(-1.13)		(-1.30)
D4		-1.09*		-0.59*
		(-1.83)		(-1.80)
D5		-0.87		-0.59
		(-1.07)		(-1.25)
R^2	0.88	0.68	0.49	

[a]Numbers in parentheses are t-ratios.
** denotes significance at 5% level or better, * denotes significance at 10% level.

Supply Response of Oil-bearing Crops

Table 23 presents the estimation results of the output and area response functions for oil-bearing crops in the northern coastal regions. There are several important findings. First, the insignificance of price coefficient in the output model implies that the output of oil-bearing crops is not responsive to its own price. Second, the Tobit model performs very well in terms of the improved t-ratios of the coefficients. According to the results obtained from the Tobit model, the growing area of oil-bearing crops responds very positively to its own price and negatively to the price of cotton. Third, the county dummy variables play important roles in explaining the acreage response, particularly in the Tobit model. The exclusion of them (column 3) generates a lower R^2 and a wrong sign of own price.

Table 23. Estimates of Output and Acreage Response of Oil-bearing Crops in the Northern Coastal Region[a]

Explanatory	Output	Acreage		
Variables	OLS	OLS-(1)	OLS-(2)	TOBIT
Intercept	4.33**	9.99	0.75	8.85*
	(7.04)	(1.58)	(0.33)	(1.93)
$Ln(P_{oil})$	0.25	0.60	-0.88	0.91**
	(0.53)	(0.83)	(-0.94)	(2.01)
$Ln(P_{cotton})$		-6.18*	0.33	-5.63**
		(-1.82)	(0.38)	(-2.33)
Ln(Sown area)	1.42**			
	(13.39)			
Ln(Land)		0.53	0.17	0.59**
		(1.54)	(0.55)	(2.49)
Ln(Labor)	0.68			
	(1.41)			
D1		0.86		0.62
		(0.84)		(0.93)
D2		1.22		1.10*
		(1.34)		(1.82)
D3		2.07**		1.93**
		(2.25)		(3.22)
D4		-0.87		-1.07**
		(-1.36)		(-2.50)
D5		-0.42		-0.24
		(-1.00)		(-0.86)
D6		-0.10		-0.30
		(-0.19)		(-0.82)
R^2	0.89	0.61	0.10	

[a]Numbers in parentheses are t-ratios.

** denotes significance at 5% level or better, * denotes significance at 10% level.

Table 24 presents the estimation results of the oil-bearing crops supply response in the southern coastal region. Almost all of the coefficients are significant at the 5% level, and the high R^2's indicate a satisfactory goodness of fit. Several findings need to be mentioned. First and most important is the growing area of oil-bearing crops is highly price elastic. If the price of oil-bearing crops increase by one percent, such crops's growing area will increase by six percent, but the output is barely price elastic. This result indicates that farmers will increase the growing area of high-valued oil-bearing crops, such as sesame and peanut. The lower yields of these crops are major reasons for the insignificant price elasticity of total output. Second, the price of the sugar-yielding crop has significant negative effect on growing area of oil-bearing crops, showing a strong competition between these two cash crops. Third, the statistic significance of dummy variables indicates that acreage response differs across counties.

Table 24. Estimates of Output and Acreage Response of Oil-bearing Crops in the Southern Coastal Region[a]

Explanatory	Output	Acreage		
Variables	OLS	OLS-(1)	OLS-(2)	TOBIT
Intercept	3.74	-36.44**	-26.2**	-27.12**
	(0.91)	(-4.52)	(-3.65)	(-4.29)
$Ln(P_{oil})$	0.54	6.47*	5.82**	5.85**
	(0.16)	(1.81)	(1.99)	(2.82)
$Ln(P_{sugar})$		-13.60**	-7.22**	-9.49**
		(-3.55)	(-2.07)	(-3.02)
Ln(Labor)	1.77			
	(0.71)			
Ln	1.23 **			
(Sown area)	(9.99)			
Ln(Land)		4.11**	4.07**	3.66**
		(5.62)	(5.01)	(8.38)
D1		-3.87**		-2.88**
		(-3.16)		(-3.50)
D2		-2.75		-2.48**
		(-1.61)		(-2.43)
R^2	0.86	0.69	0.55	

[a]Numbers in parentheses are t-ratios.
** denotes significance at 5% level or better, * denotes significance at 10% level.

Supply Response of Fresh Vegetables

Table 25 summarizes the estimation results of vegetables output and acreage response functions in the northern coastal region. The own-price coefficients are not statistically significant, indicating that vegetable output and acreage are not influenced by their own prices. Column 1 shows that the growing area and the usage of chemical fertilizer are significant factors influencing vegetable output. The acreage response results in columns 2 and 4 show that vegetable growing area responds positively and significantly to labor force number and negatively to the proportion of household non-farm income. This is not surprising since vegetable production presumably is very labor intensive. The more the household non-farm income, the less the agricultural laborers available in the household. Finally, vegetable growing area responds negatively to household land area. A possible explanation may be that the households with more land would not produce as much as vegetables as those with less land because of labor intensity for vegetable production.

Table 25. Estimates of Vegetable Output and Acreage Response in the Northern Coastal Region[a]

Explanatory	Output	Acreage		
Variables	OLS	OLS-(1)	OLS-(2)	TOBIT
Intercept	6.11**	0.06	-0.85	-0.60
	(6.32)	(0.06)	(-0.71)	(-0.87)
$Ln(P_{vegetable})$	0.22	0.23	0.79**	0.17
	(0.93)	(0.84)	(2.75)	(0.75)
Ln(Fertilizer)	0.27*			
	(1.84)			
Ln(Sown (Area)	0.69 **			
	(7.22)			
Ln(labor)		1.44**	0.41	1.33**
		(2.50)	(0.52)	(2.83)
Ln(land)		-0.74**	-0.06	-0.47**
		(-2.65)	(-0.17)	(-2.01)
NFI		-4.27**	-0.15	-3.20**
		(-4.82)	(-0.18)	(-4.06)
D1	-0.72**	0.35		0.36
	(-2.59)	(1.03)		(1.25)
D2	-0.78**	2.72**		2.43**
	(-2.49)	(5.64)		(6.03)
D3	-0.25	0.85**		0.81**
	(-0.9)	(2.52)		(3.12)
D4	-0.14	0.40		0.94**
	(-0.46)	(0.92)		(2.92)
D5	-0.48*	1.19**		1.21**
	(-1.70)	(3.01)		(3.68)
D6	-0.01	-0.46		-0.34
	(-0.10)	(-1.16)		(-1.14)
R^2	0.67	0.62	0.12	

[a]Numbers in parentheses are t-ratios.
** denotes significance at 5% level or better, * denotes significance at 10% level.

Table 26 presents the estimation results for the southern coastal region. Column 1 shows that growing area and the usage of chemical fertilizer are the most important factors influencing vegetable output in the south. The results in column 2 and 4 show that the vegetable growing area in the southern coastal region responds positively to household land and negatively to household labor and proportion of non-farm income. These findings are consistent with the increasing scarcity of arable land and rapid development of rural industry in the south. If there is more arable land, farmers would allocate more land to vegetable production due to its higher profitability. On the other hand, the higher wages in rural industries increase the cost of labor, preventing farmers from labor-intensive vegetable production.

Table 26. Estimates of Vegetable Output and Acreage Response in the Southern Coastal Region[a]

Explanatory	Output	Acreage		
Variables	OLS	OLS-(1)	OLS-(2)	TOBIT
Intercept	5.67**	0.39	-2.19*	1.78
	(6.31)	(0.21)	(-1.73)	(1.43)
$Ln(P_{vegetable})$	0.25	0.98*	0.53	0.29
	(0.86)	(1.67)	(0.94)	(0.75)
Ln(Fertilizer)	0.22*			
	(1.66)			
Ln(Sown Area)	0.27**			
	(3.80)			
Ln(Labor)		-1.20	-0.77	-0.62
		(-1.22)	(-0.85)	(-0.81)
Ln(Land)		0.83*	1.18**	0.11
		(1.79)	(2.81)	(0.40)
NFI		-0.30	1.15	-1.97
		(-0.18)	(0.99)	(-1.58)
D1	-0.29	-0.72		-0.49
	(-1.05)	(-1.17)		(-1.17)
D2	-0.41	-1.32		-1.49**
	(-1.13)	(-1.62)		(-2.48)
D3	0.48*	0.22		0.24
	(1.76)	(0.40)		(0.62)
D4	-0.10	-0.80		-0.21
	(-0.32)	(-1.24)		(-0.45)
D5	-0.13	-0.93		-0.37
	(-0.43)	(-1.28)		(-0.74)
R^2	0.53	0.30	0.17	

[a]Numbers in parentheses are t-ratios.
** denotes significance at 5% level or better, * denotes significance at 10% level.

Supply Response of Livestock Products

Table 27 presents the estimation results of pork output response in the coastal region. Results in columns 1, 2 and 3 correspond to the models without the three provincial dummy variables, with dummy variables, and with the cross-product terms of the dummy variables and price. The most important finding is that the own-price coefficients have the expected positive signs and are highly significant, indicating that pork price greatly influences pork output in the coastal region. In addition to price, household expenditure on livestock production has positive effect on pork output. According to my estimation, household pork output will increase by 0.5 percent if the input expenditure on livestock production increases by one percent. The t-ratios of the provincial dummy variables are not statistically significant, implying that there are not significant differences in pork output response across provinces.

Table 28 presents the poultry meat output response in the coastal region. The following findings are of importance. First, poultry meat output is very responsive to its own price and the price of eggs. Most of the price coefficients are statistically significant. Second, two provincial dummy variables are statistically significant, i.e., D1 and D3, representing the two northern provinces: Jiangsu and Shandong. This finding indicates that there exist great differences in the price elasticities of poultry meat supply between northern and southern provinces. Further investigation is reported in column 3. The price elasticity in the south (Guangdong and Fujian) is around 0.9, which is much higher than that in the north, which is about 0.2. This difference may be caused by the different poultry meat consumption patterns between the north and south.

Table 29 presents the estimation results of egg output response in the coastal region. The own price coefficients are not statistically different from zero in the three specifications. The model without dummy variables has the lowest R^2. The t-ratios of the two provincial dummy variables (D1 and D3 for Jiangsu and Shandong) are statistically significant, indicating that there are significant differences in fresh egg production between the north and south. The results from the model with cross-product terms (column 3) show that the egg output in the north (Jiangsu and Shandong) is very price elastic. However, egg price does not have a significant effect on its output in the south.

Table 27. Estimates of Pork Output in the Coastal Region[a]

Explanatory Variables	OLS-(1)	OLS-(2)	OLS-(3)
Intercept	0.09	-0.02	-0.10
	(0.15)	(-0.02)	(-0.13)
$Ln(P_{pork})$	0.83**	0.78**	0.82**
	(2.19)	(1.83)	(1.93)
Ln	0.51**	0.54**	0.55**
(Expenditure)	(8.49)	(7.69)	(7.78)
D1		-0.05	
		(-0.31)	
D2		0.06	
		(0.40)	
D3		0.10	
		(0.56)	
$D1*Ln(P_{pork})$		-0.01	
		(-0.14)	
$D2*Ln(P_{Pork})$		0.03	
		(0.29)	
$D3*Ln(P_{pork})$		0.08	
		(0.71)	
R^2	0.47	0.48	0.48

[a]Numbers in parentheses are t-ratios. The dummy variables are defined as D1=1 for Jiangsu, D2=1 for Fujian, D3=1 for Shandong.
** denotes significance at 5% level or better, * denotes significance at 10% level.

Table 28. Estimates of Poultry Output in the Coastal Region[a]

Explanatory Variables	OLS-(1)	OLS-(2)	OLS-(3)
Intercept	-5.07**	-0.59	-2.7*
	(-4.14)	(-0.36)	(-1.92)
$Ln(P_{poultry})$	1.13**	0.38	0.91**
	(5.46)	(1.58)	(3.96)
$Ln(P_{eggs})$	1.85**	0.89	1.23
	(2.26)	(1.06)	(1.44)
Ln	0.37**	0.27**	0.32**
(Expenditure)	(3.11)	(2.39)	(2.75)
D1		-1.70**	
		(-5.41)	
D2		-0.31	
		(-1.03)	
D3		-1.54**	
		(-3.98)	
$D1*Ln(P_{poultry})$			-0.70**
			(-4.47)
$D2*Ln(P_{Poultry})$			-0.09
			(-0.66)
$D3*Ln(P_{poultry})$			-0.63**
			(-3.34)
R^2	0.50	0.64	0.61

[a]Numbers in parentheses are t-ratios. The dummy variables are defined as D1=1 for Jiangsu, D2=1 for Fujian, D3=1 for Shandong.
** denotes significance at 5% level or better, * denotes significance at 10% level.

Table 29. Estimates of Egg Output in the Coastal Region[a]

Explanatory Variables	OLS-(1)	OLS-(2)	OLS-(3)
Intercept	4.51**	-0.42	0.66
	(3.22)	(-0.24)	(0.43)
$Ln(P_{egg})$	0.34	0.92	0.37
	(0.37)	(1.10)	(0.48)
$Ln(P_{poultry})$	-0.87**	0.13	0.10
	(-2.79)	(0.45)	(0.35)
Ln	-0.16	0.04	0.04
(Expenditure)	(-1.04)	(0.31)	(0.28)
D1		1.60**	
		(4.90)	
D2		-0.37	
		(-1.05)	
D3		1.68**	
		(4.13)	
$D1*Ln(P_{egg})$		0.92**	
			(4.97)
$D2*Ln(P_{egg})$			-0.31
			(-1.47)
$D3*Ln(P_{egg})$			0.99**
			(4.25)
R^2	0.20	0.50	0.51

[a]Numbers in parentheses are t-ratios. The dummy variables are defined as D1=1 for Jiangsu, D2=1 for Fujian, D3=1 for Shandong.
** denotes significance at 5% level or better, * denotes significance at 10% level.

Estimation Results for Food Demand Analysis

This section presents the regression results for the Rotterdam demand model developed by Theil (1965). As noted earlier, this model is estimated for ten major food items. Therefore, the weak separability is assumed for this group of foods, implying that the demand for these ten foods are weakly separable from the demand for the other foods and other goods and services.

To test the properties of the demand system with this data set, the chi-square statistics value under different model specifications are presented in Table 30. Gallant and Jorgenson (1979) show that the change in the least squares criterion function can be used as an asymptotically valid chi-square test. We have four types of hypotheses: no constraints, or imposing homogeneity, symmetry, or both homogeneity and symmetry. The tests of these hypotheses are reduced to the test of the restrictions on the parameters of demand system, and they are based on the objective values of different specifications. The difference between the objective values for a less restrictive model and the corresponding value for a more restrictive model is asymptotically distributed as a chi-square under the null hypothesis of the more restrictive model. The degrees of freedom are computed by the difference in the number of the free parameters between the less restrictive model and more restrictive model. For a quick reference, the chi-square table values for 9, 36 and 45 degree of freedom at the 5% level of significance are provided in Table 30. It can be seen that all the hypotheses of homogeneity or symmetry or both are rejected, indicating that the properties of demand system derived from the neoclassical theory of consumer behaviors are not valid by using food consumption data in urban China.

Table 30. Chi-square statistics values[a]

Homogeneity vs. No constraints	Symmetry vs. No constraints	Homogeneity and Symmetry vs. No constraints
88.73 (9)	161.12 (36)	211.14 (45)
$\chi^2_9(0.05)=16.92$,	$\chi^2_{36}(0.05)=43.77$,	$\chi^2_{45}(0.05)=55.76$.

[a]The figures in the parentheses are degrees of freedom.

The goodness of fit of the model estimated under different specifications is judged from the R^2's. Table 31 presents a grouped distribution of R^2's. The results indicate that the overall goodness of fit is satisfactory. Of the total 36 equations estimated, 15 equations have R^2's greater than 0.7, and 12 have R^2's between 0.7 and 0.4. In the first category, the frequency doesn't change much as we move from the unconstrained model to more restrictive model. Therefore, the explanatory power of the demand model is not influenced by the imposition of a restriction. However, in the third category, the frequency increases as we move from the unconstrained model to additive ones.

Table 31. Frequency Distribution of the R^2's Under Different Model Specifications

Specification	$R^2 > 0.7$	$0.7 \geq R^2 \geq 0.4$	$R^2 < 0.4$	Total
Unconstrained	4	4	1	9
Homogeneity	4	4	1	9
Symmetry	3	3	3	9
Homogeneity and Symmetry	4	1	4	9
Total	15	12	9	36

The estimated income coefficients (i.e., the marginal budget shares) under different model specifications are given in Table 32. All the marginal budget shares are positive except for rice and wheat. It can be seen that the income coefficients are highly sensitive to the model specification. The marginal budget shares of fresh vegetables, fish and shrimp increase with the imposition of restrictions; while those for beef and mutton, fresh eggs and fresh fruits decrease as we move from unconstrained models to additive ones. The marginal budget shares for pork, poultry and edible oils are least sensitive to the imposition of restrictions.

The results also reveal consumers' preference for various food items. More specifically, an urban consumer spends about 62% of his additional food expenditures on pork, 10% on poultry and 20% on fresh fruits. It can be seen that the increase in demand for animal products, particularly for pork will exceed that for other food items. The negative sign of the marginal budget share of rice and wheat indicate that urban consumers in the coastal region decrease the grain consumption as the food expenditures increase. These results reveal an important trend of food consumption in urban China: the proportion of grain consumption will decrease and livestock consumption will increase with additional income.

Table 32. Estimates of Marginal Budget Shares

Commodity Group	Uncon-strained	Homo-geneity	Sym-metry	Homogeneity and Symmetry
Wheat	-0.0032	-0.007	-0.011	-0.012
Rice	-0.037	-0.036	-0.004	-0.004
Edible Oil	0.022	0.021	0.02	0.019
Vegetable	0.035	0.031	0.062	0.067
Pork	0.62	0.63	0.62	0.62
Beef and Mutton	0.021	0.018	0.006	0.006
Poultry	0.095	0.090	0.101	0.099
Fresh Egg	0.029	0.031	0.026	0.019
Fish and Shrimp	0.023	0.021	0.043	0.045
Fresh Fruit	0.195	0.201	0.137	0.141

The expenditure elasticities are given in Table 33. One remarkable feature of these estimates is that they are not sensitive to model specification. The expenditure elasticities of wheat and rice are negative, showing that in the urban coastal area, wheat and rice are becoming inferior foods. This result, to some extent, supports the findings by Ito, Peterson and Grant (1989) who claimed that rice income elasticities are highly negative in many Asian countries and only slightly positive and declining over time in other Asian countries. Within food grains, wheat consumption decreases faster than that of rice with greater income, indicating that rice will remain the dominant food grain in this region. All the other food commodities have positive expenditure elasticities. Among them, pork, fresh fruits and poultry have expenditure elasticities greater than 1.

Since the Rotterdam model is estimated for the ten major food items, expenditure elasticities obtained from the the model are defined with respect to expenditure for these ten foods. In order to convert these expenditure elasticities to income elasticities, we need to know the income elasticity for the ten food groups, i.e., d(lny)/d(lnx), where y is expenditure for ten food groups, and x is total income. Simple linear regressions using the data for the coastal region during 1985-91yield the estimated income elasticity of 0.927. Multiplying expenditure elasticities by 0.927 yields the income elasticities with respect to total income (Table 34). This set of income elasticities will be used in Chapter 5 for a comparative analysis of income effects of food demand in Mainland China.

According to the results in Table 34, pork, fresh fruits and poultry have the marginal budget shares greater than one percent, indicating that as income increases, urban consumers in the coastal region will allocate more of their money for pork, fresh fruits, and poultry.

Table 35 presents the estimated compensated own-price elasticities. It can be seen that the estimated price elasticities are more sensitive to model specification, except for rice, vegetables, fresh eggs, fish and shrimp: for which the range of variation of the own-price elasticities is smaller than that of other food items. In is interesting to note that, in the unconstrained model, the compensated own-price elasticities are positive for three food commodities. With homogeneity and symmetry conditions imposed, all of the compensated own-price elasticities have the expected negative sign except for beef and mutton. However, magnitudes of these positive compensated own-price elasticities are very small.

One important feature of the estimates of own-price elasticities is that the demand for wheat, edible oil, fresh eggs, fish and shrimp, and poultry are price elastic: ranging from -0.73 to -1.24. The demands for rice and pork are barely influenced by their own prices. We think that the dietary tradition is the major reason for lower price elasticity of demand for rice. The reason for the lower price elasticity of demand for pork may be that it is difficult to substitute other meats for pork because the relative higher prices of other meats. The intermittent rationing on grain and pork consumption during the study period might be another reason.

Another striking finding is that the own-price elasticity of demand for poultry is greater than unity. Based on the derived income elasticity of demand for poultry, it can be concluded that future demand for poultry will be greatly influenced by its own price rather than the consumer's income.

Table 33. **Estimates of the Total Expenditure Elasticities**

Commodity Group	Uncon-strained	Homogeneity	Symmetry	Homogeneity and Symmetry
Wheat	-0.11	-0.20	-0.42	-0.42
Rice	-0.42	-0.41	-0.04	-0.04
Edible Oil	0.44	0.42	0.40	0.37
Vegetables	0.21	0.18	0.36	0.39
Pork	2.46	2.47	2.45	2.43
Beef & Mutton	0.68	0.58	0.22	0.20
Poultry	1.10	1.13	1.15	1.14
Fresh Eggs	0.31	0.32	0.27	0.20
Fish & Shrimp	0.17	0.17	0.36	0.37
Fresh Fruits	2.48	2.50	1.69	1.81

Table 34. **Income Elasticities with Respect to Total Living Expenditure**

(Both Homogeneity and Symmetry Conditions Are Imposed)

Commodity Group	Income Elasticity
Wheat	-0.39
Rice	-0.04
Edible Oil	0.34
Vegetables	0.36
Pork	2.25
Beef & Mutton	0.19
Poultry	1.06
Fresh Eggs	0.19
Fish & Shrimp	0.34
Fresh Fruits	1.68

Table 35. Estimates of Compensated Own-Price Elasticities

Commodity Group	Uncon-strained	Homogeneity	Symmetry	Homogeneity and Symmetry
Wheat	0.30	-0.81	-0.62	-0.73
Rice	-0.04	-0.05	-0.06	-0.04
Edible Oil	-0.61	-0 52	-1.19	-0.82
Vegetables	-0.35	-0.23	-0.44	-0.37
Pork	-0.09	-0.02	-0.14	-0.12
Beef & Mutton	0.02	0 11	0.06	0.06
Poultry	-1.55	-1.38	-1.36	-1.24
Fresh Eggs	-1.08	-1.03	-0.80	-0.80
Fish & Shrimp	-0.96	-0.97	-0.95	-0.94
Fresh Fruits	0.13	0.10	-0.36	-0.42

Table 36 presents the estimated uncompensated own-price elasticities under the alternative model specifications. In the unconstrained model, all of the own-price elasticities are negative except for wheat. With homogeneity or symmetry or both conditions imposed, the own-price elasticity of demand for wheat becomes negative, while for beef and mutton, it is positive. This may be caused by the shortage in beef and mutton supply in the coastal region.

Comparing the compensated and uncompensated own-price elasticities under different specifications, it is notable that the uncompensated demand for pork is highly price elastic.

Even though pork is the major red meat in Chinese people's diet, the demand is highly influenced by its own price if the effect of price change is not compensated.

Table 36. Estimates of the Uncompensated Own-Price Elasticities

Commodity Group	Uncon-strained	Homogeneity	Symmetry	Homogeneity and Symmetry
Wheat	0.30	-0.81	-0.61	-0.72
Rice	-0.002	-0.015	-0.05	-0.04
Edible Oil	-0.64	-0.54	-1.21	-0.84
Vegetables	-0.39	-0.27	-0.51	-0.43
Pork	-0.72	-0.65	-0.76	-0.74
Beef & Mutton	-0.002	0.09	0.06	0.05
Poultry	-1.64	-1.47	-1.46	-1.34
Fresh Eggs	-1.10	-1.06	-0.83	-0.82
Fish & Shrimp	-0.98	-0.98	-0.99	-0.99
Fresh Fruits	-0.06	-0.10	-0.48	-0.57

Because of the need to establish a well-fitted demand model for food commodities in urban China, the model imposing both homogeneity and symmetry is chosen for computing the entire demand elasticity matrix.

Table 37 presents the uncompensated own-price and cross price elasticities of the ten major food commodities. The uncompensated demand for almost every food commodity is highly influenced by the prices of one or more other foods. For example, the uncompensated demand for pork is very sensitive to changes in the prices of fresh vegetables, and fish and shrimp. The uncompensated demands for both fresh eggs and fresh fruits are highly influenced by the changes in pork price. This elasticity matrix will be used in the forecasting model to be developed next year.

Table 37. Uncompensated Price Elasticities of Food Commodities with Homogeneity and Symmetry Imposed

Commodity Group	j=1	2	3	4	5	6	7	8	9	10
1. Wheat	-0.72	0.15	0.52	-0.23	0.26	0.03	0.27	0.05	-0.65	0.74
2. Rice	0.04	-0.04	-0.005	0.05	-0.16	-0.06	0.16	0.009	0.14	-0.10
3. Edible Oil	0.27	-0.05	-0.84	0.04	0.79	-0.25	-0.12	-0.56	0.63	-0.26
4. Fresh Vegetables	-0.06	-0.01	0.01	-0.43	-0.20	-0.007	0.12	0.04	0.04	0.11
5. Pork	-0.05	-0.27	0.05	-0.48	-0.74	-0.02	-0.26	-0.01	-0.40	-0.22
6. Beef & Mutton	0.01	-0.20	-0.38	-0.01	0.40	0.05	0.14	-0.16	0.04	-0.09
7. Poultry	0.04	0.06	-0.11	0.11	-0.45	0.02	-1.34	0.11	0.58	-0.16
8. Fresh Fruits	-0.002	-0.01	-0.29	0.09	0.52	-0.05	0.18	-0.82	0.11	0.05
9. Fish & Shrimp	-0.16	0.06	0.25	0.06	-0.31	0.005	0.49	0.07	-0.99	0.15
10. Fresh Fruits	0.20	-0.26	-0.24	0.004	-0.58	-0.08	-0.24	-0.08	0.05	-0.57

Chapter 5

Assessment of Lester Brown's Prediction

There was another important event happened in 1994. The September/October 1994 issue of World Watch published an article by Lester R. Brown, entitled "Who Will Feed China?" The article shocked the whole of Mainland China, and stirred heated debates among policy makers, scholars, and analysts.

Brown pointed out that China's population is growing by 14 million people a year and incomes are climbing at a record rate. On the demand side, he argued as household income increases, people will consume more meats which require feed grains to produce. On the supply side, he claimed Mainland China's capacity to produce food will shrink as a result of converting cropland to non farm uses. He predicted that Mainland China will face a growing gap between market demand for food and its production. Specifically, he predicted that by 2030, China's grain deficit will have risen to 305 million tons a year and imported grain will account for 56% of total grain consumption. He concluded that no country or combinations of countries can fill this huge projected food deficit in China.

Brown's study is not the only prediction ever made of Mainland China's future deficit of grain. In 1989, Perkins (1992) carefully assessed China's grain demand and supply and predicted a widening deficit of grain. Specifically, he predicted that if income per capita grows at 5 or 6% per year and production only at 2%, then grain imports could be as high as 80 to 100 million tons a year by the year 2000. On the other hand, if demand growth is lower and grain production faster, Mainland China may be possible to hold net imports to 30-

40 million tons by 2000. Brown's prediction is, by far, much more pessimistic than Perkins' in terms of China's ability to feed its people.

Despite the question on the credibility of Brown's view, his thesis points out the importance of the changing food consumption pattern in evaluating the potential problems of a grain deficit Mainland China will face in the future. The role of consumption or consumers distinguishes a market economy from a centrally planned economy. In a market economy, consumers determine the market demand for consumer goods such as food and price is determined by demand and supply rather than by government control. As will be the case elsewhere, changing demands for various foods will have profound impacts on the prices of food, on farm income as well as on the imports or exports of agricultural and food products in Mainland China.

In this chapter, we will first present a brief summary of the responses by the Chinese Academy of Sciences to Brown's prediction, and proceed to analyzing the recent trends of food consumption pattern in Mainland China, to review the available estimates of income elasticities for staple and nonstaple foods, to assess these estimates in view of the effects of food rationing, and to discuss the implications of the changing pattern of food consumption in view of Brown's pessimistic prediction.

Assessment of the Chinese Academy of Sciences

In response to the ongoing debates on China's ability to feed its people generated by Brown's article mentioned earlier, the Chinese Academy of Sciences (CAS) undertook a study entitled, "China's Agricultural Production: Problems, Prospects, and Strategies" by a group of expert scientists. The report of the study was published in Chinese Science News (No. 748, Beijing, March 6, 1995.) Some important findings and policy recommendations are briefly summarized here.

The study focused on answering the following question: "Can China increase grain production by 50 million tons by 2000?" This is a policy target which was believed by Chinese leaders as what it will take to resolve Mainland China's food deficit problem.

The report began with an analysis of recent trends of agricultural production by region. Here are several important trends pointed out in the report:

(1) From 1978 to 1984, total grain production increased from 305 to 407 million tons with the corresponding yield increasing from 168 kg per mu to 240 kg, an increase of 42.8%.

(2) From 1984 to 1993, total grain production increased from 407 to 456 million tons with the corresponding yield increasing from 240 kg to 275.6 kg, a mere increase of 14.6% during this nine-year period. During this period, the acreage of grain production declined, and despite the rapid increases in fertilizer uses, the growth of grain production slowed down.

(3) The region with notable declines in the growth of grain production was the southeastern region (including many coastal provinces). The reasons for the slow growth in this region are (1) declines in arable land, (2) declines in the planted areas for grains, and (3) slowdown of the growth in grain productivity.

The report argued that China still has the potential to increase grain production by 50 million tons by 2000 if it follows the following strategies:

(1) To make the protection of farmland and the maintenance of stable grain producing acreage as priorities in Mainland China's agricultural policy.

(2) To accelerate the nation's production capacity of phosphates and potash.

(3) To improve irrigation and increase irrigated farmland.

(4) To improve plant breeding and varieties of crops, and agricultural extension.

(5) To increase agricultural investment in technology and farming skills.

In order to reduce the pressure on the increasing demand for grain, the study assessed the prospects of increasing the production of livestock and aquatic products. It concluded that Mainland China can greatly expand its grassland for raising livestock and its uses of ocean resources for seafood production.

The recommendations provided in the report highlight once again the current strategies for agricultural development in Mainland China. Agricultural policy makers are mainly concerned about the declines in grain production rather than the potential foreign exchange earnings from agricultural exports.

Food Consumption Pattern in China

In 1993, Mainland China has 852 million rural consumers and 333 million urban consumers. Urban households are important for the agricultural sector in China because they are major buyers of agricultural commodities in the market place. Most of rural households tend to be self sufficient in many of food items they consume. Thus urban households will likely provide the dynamic economic force in determining what are the most profitable food commodities to produce.

China has encountered many demographic changes during the last 15 years. Specifically, migration from rural to urban areas has occurred at a very rapid rate despite the restriction in urban residence registration. Consequently, the percentage of urban population increased from 17.9% in 1978 to 28.1% in 1993 (State Statistical Bureau, 1994). It is, therefore, important to compare the food consumption patterns between rural and urban households.

Table 40 shows per capita food consumption by rural households. These data are based on Chinese rural household survey conducted by State Statistical Bureau (SSB). These figures include quantities of both self produced and purchased foods. As mentioned, rural households had very high self-sufficiency rates for food consumption. Table 41 shows the self-sufficiency ratios for selected food items in 1991. Grains were virtually all self produced. Vegetables had a self-sufficiency ratio of 85%, while more than 40% of meats and more than 50% of fruits were self produced. Although there were no data available for poultry, its self-sufficiency ratio would probably be much higher than pork and beef. Only for such processed foods as sugar, cakes and candy, did rural households purchase rather than self-supply their needs. These high self-sufficiency ratios raise a methodological issue on estimation of the demand for food, particularly grain, for rural households in China. The data in Table 41 were obtained for 1991. One would expect higher self-sufficiency ratios for earlier years.

From Table 40, we can see the historical "consumption" trends of major staple and non- staple foods by Chinese rural households. For grains, per capita consumption figures have remained fairly constant during this period of 1978 to 1993. The per capita consumption of edible oil registered drastic increases during 1978-1988 but further increases were very marginal since 1989. For most nonstaple foods, notable increases in per capita consumption occurred during 1978 - 1988 but after that the trends have been either very flat or fluctuating. It is interesting to note that meat consumption did not show a steadily increasing trend in recent years, and vegetable consumption has been declining.

What can we learn from these observations of food consumption patterns by Chinese rural households? It appears that these trends provide little basis for detecting any effects of income changes on food consumption. During this period of economic reforms, rural households have raised their income substantially. Specifically, per capita net income of rural households increased from 133.57 yuan (in nominal term) in 1978 to 601.5 yuan in 1989 (SSB, 1994). The growth slowed down in 1990 and 1991 (with only 3.2% annual increase in both years). In 1992 and 1993, the annual rates of increase in net income were 10.6% and 17.5%, respectively. With the inflation rates running at 2.1% (1990), 2.9% (1991), 5.4% (1992), and 13.0% (1993), the net income in real terms of rural households still increased during this recent period of 1990-1993. It would seem reasonable to expect strong income effects on the demand for nonstaple foods, if not staple food in Mainland China. Despite the fact that consumption trends were sharpened by changes in both prices and income, these observed trends raised a serious question on whether or not the true food demand behavior by rural households can be revealed from these "consumption" data. Most of these data might not be generated from the consumer's utility maximization under budget constraint because only a small fraction of the net income of rural households was used in buying these food items.

Table 40. Annual Per Capita Food Consumption by Rural Households, Mainland China

Unit = kg

Item	1978	1980	1985	1988	1989	1990	1991	1992	1993
Grain[a]	247.83	257.16	257.45	260.00	262.00	262.08	255.58	250.50	266.02
Wheat & Rice	122.51	162.92	208.85	211	213	215.02	213.82	210.63	221.02
Edible Oil	2.96	3.49	4.04	4.76	4.82	5.27	5.65	5.85	5.66
Vegetables	142.00	127.00	131.00	130.00	133.00	134.99	126.97	129.12	107.43
Meats	5.76	7.75	10.97	10.71	11.00	11.34	12.15	11.83	11.68
Pork	5.17	7.27	10.32	10.05	10.28	10.54	11.19	10.88	10.86
Beef & Mutton	0.59	0.48	0.65	0.66	0.72	0.80	0.96	0.95	0.82
Poultry	0.25	0.66	1.03	1.25	1.28	1.26	1.34	1.49	1.62
Eggs	0.80	1.20	2.05	2.28	2.41	2.41	2.73	2.85	2.88
Aquatic Products	b								2.76
Fish & Shrimp	0.84	1.20	1.64	1.91	2.14	2.13	2.21	2.25	2.47
Fruits							6.79	7.54	7.83
Sugar	0.73	1.06	1.46	1.41	1.50	1.50	1.40	1.54	1.43

[a]Based on unprocessed grains.
[b]Blanks indicate data not available.

Sources: (1) State Statistical Bureau, Statistical Yearbook of China, 1994.
(2) State Statistical Bureau, Yearbook of Chinese Rural Household Survey, 1992.

Table 41. Self-sufficiency Ratios of Rural Households, Mainland China, 1991

Item	Consumed Per Capita (kg)	Purchased Per Capita (kg)	Self-Sufficiency Ratio (%)
Grains	255.58	0	100
Vegetables	126.97	19.22	84.9
Pork	11.19	6.31	43.6
Beef & Mutton	0.96	0.53	44.8
Sugar	1.40	1.39	0
Cakes	1.05	0.92	12.4
Candy	0.31	0.28	9.7
Fruits	6.79	3.21	52.7

Source: State Statistical Bureau, Yearbook of Chinese Rural Household Survey, 1992.

Table 42 shows per capita consumption of grains and other staples by urban households from 1985 to 1994. Note that in 1994, the food market was supposed to be totally free from the rationing of grains and edible oils while in 1993, food rationing was still intact until May that year. Therefore, we need to bear in mind, these historical trends were sharpened by changing market forces. In particular, during 1985-1994, Chinese urban households encountered diminishing government intervention over time. These observed consumption patterns must have been affected by food rationing, an issue to be revisited later.

Table 42 shows that grain consumption by urban household has steadily declined. One typical explanation is that urban consumers have been consuming less grains but better quality. However, if we look at the trends of fine grains, or rice in particular, the trends have been downward. On the other hand, the per capita consumption of edible oil (vegetable oil) has steadily increased throughout this period. It is interesting to note that the consumption of most nonstaple food items dropped in 1993, perhaps as a shock following the removal of grain rationing. However, consumption of total grains and most staple food increased in 1994, perhaps as signs of recovery from the shock.

Due to rationing, it would not be appropriate to detect the income effect on the consumption of these staple foods. However, the declining trends of grain consumption and increasing trend of edible oil tend to have a more consistent correlation with the steadily increasing trend of income by urban households than previously observed for rural households. Specifically, per capita annual nominal income of urban households increased from 768.92 Yuan in 1985 to 1.522.79 Yuan in 1990 (SSB, 1994 p259). Since 1990, the annual rates of increase in income were 12.5% (1991), 18.5% (1992), and 27.2% (1993).

Per capita consumption data of selected nonstaple foods by Chinese urban households are shown in Table 43. Pork is perhaps the most important nonstaple food in the Chinese diet. Its per capita consumption steadily increased from 1985 to 1991 and then declined in recent

years from 1992 to 1994. In fact, several other nonstaple foods have followed this same pattern of changes. The decreases in per capita consumption in 1993 and 1994 were perhaps due to the impacts of drastic increases in their prices. Even under such inflationary pressure, the per capita consumption of eggs and poultry continued to increase, reaching its highest level in 1994. These statistics suggest that the impacts of rising income on the demand for nonstaple foods are more detectable for urban households than for rural households.

Table 42. Per Capita Consumption of Grains and Other Staples by Chinese Urban Households, Mainland China

(kg)

Item	1985	1988	1989	1990	1991	1992	1993	1994
Total Grains	134.76	137.17	134.03	130.72	127.93	111.5	97.78	101.67
Fine Grains	[a]	107.23	108.35	104.61	103.97	107.33	95.34	99.24
Rice		60.44	59.08	56.72	56.69	54.09	52.64	54.27
Flour[b]		40.11	39.81	38.56	38.81	[a]43.19	[a]32.47	[a]34.02
Bread						0.89	0.95	0.80
Coarse Grain		11.27	10.28	10.69	9.29	4.16	2.44	2.43
Potato						8.78	8.60	9.15
Soybeans						0.32	0.24	0.28
Edible Oil[c]	5.76	6.96	6.16	6.40	6.93	6.65	7.14	7.52

[a]Blanks indicate data not available.
[b]Data includes standard flour, enriched flour, bread and steamed bread.
[c]Includes only vegetable oils.

Sources: (1) State Statistical Bureau, Statistical Yearbook of China, 1994.
(2) State Statistical Bureau, Income and Expenditure Survey of Chinese Urban Households, 1985-1991.
(3) State Statistical Bureau, unpublished tables from Income and Expenditure Survey of Chinese Urban Households, 1992-1994.

Table 43. Per Capita Consumption of Nonstaple Foods By Chinese Urban Households, Mainland China

(kg)

Item	1985	1988	1989	1990	1991	1992	1993	1996
Pork	16.68	16.94	17.53	18.46	18.86	17.7	17.4	17.12
Beef & Mutton	2.04	2.81	2.73	3.28	3.34	3.71	3.36	3.10
Beef	[a]					2.15	2.08	1.93
Poultry	3.24	4.00	3.65	3.42	4.40	5.08	5.20	5.67
Slaughtered Chicken						1.14	1.33	1.54
Live Chicken						2.05	1.93	2.16
Eggs	6.84	6.87	7.05	7.25	8.26	9.45	9.36	10.17
Aquatic Products	7.08	7.07	7.61	7.69	8.02	8.19	8.02	
Fresh Vegetables	144.36	147.02	144.56	138.70	132.18	124.91	120.64	120.74
Sugar	2.52	2.58	2.38	2.14	1.80	1.85	1.77	1.91
Fruits[b]		39.73	41.73	44.32	44.7	47.78	44.55	45.53
Apple						7.72	8.28	7.99
Orange						3.81	4.17	4.42
Fresh Milk		4.12	4.24	4.63	4.68	5.52	5.38	5.25
Powder Milk						0.43	0.42	0.42
Yogurt						0.37	0.32	1.04

[a]Blanks indicate data not available.
[b]Fruits and melons (both fresh and dried).

Sources: Same as in Table 42.

Table 43 also shows several interesting patterns of changes in food consumption by urban households. Similar to rural households, per capita consumption of fresh vegetables has steadily declined. As income increases, Chinese urban households have increased notably their consumption of slaughtered chicken as compared with live chicken. Orange is another nonstaple food, showing a phenomenal growth in per capita consumption particularly in 1994.

Comparing with rural households, urban households consumed much more meats, poultry, fish, eggs, sugar, and edible oil but much less grain and about the same amount of vegetables. As rural households raise their incomes, they are likely to follow urban households to consume less grain and more meats and poultry. However, whether or not these trends can be extended into the future depends upon the consumer's demand responsiveness (measured by elasticities) to changes in income and prices and future levels of household income and food prices. It is, therefore, important to assess these elasticities of food demand in China.

Evidence of Income Effects

The demand for a food is affected by income and prices (own-price as well as cross-prices). However, relative prices play a more dominant role affecting substitution in the short run. Income effect is likely to be more influential in sharpening the long-term trends of food demand. Therefore, any long-term prediction of food demand such as those by Perkins and Brown should be evaluated on the basis of income effect rather than price effect unless there exists a persistent trend of increasing or decreasing prices for a particular food. It is for this reason, we would focus on reviewing the evidence of income effect on food demand in

China.

While Perkins (1992) made his prediction of China's grain deficit, he used the range of income elasticities of grain demand (including both food and feed grains) between 0.5 and 0.7. He did not estimate those income elasticities of grain but simply based on similar estimates obtained from Taiwan in the period of 1962-1966 with per capita GDP comparable to that observed in Mainland China in late 1980s. These elasticities were assumed for the total population. However, most available food demand studies were done for either rural or urban households. Consider first rural households. Despite the question raised earlier about the high self-sufficiency ratios for food consumed by rural households and their impacts on the observability of their food consumption behavior, several studies were conducted to estimate food demand elasticities, using SSB's survey data and other sources. Table 44 provides a summary of the estimated income elasticities from four recent studies. Fan et al. (1995) and Lewis and Andrews (1989) used a national sample of provincial data while Halbrendt et al. (1994) and Huang and Rozelle (1994) used household data from a province. All four studies used various complete demand systems such as the linear expenditure system (LES) and the linear approximate almost ideal demand system (LA/AIDS), and included food and nonfood categories. Even though several models include food demand in a subsystem, all expenditure elasticities were converted to those defined with respect to total expenditures of food and nonfood items. Therefore, these total expenditures elasticities are equivalent to the income elasticities defined in the neoclassical demand theory. The income elasticities presented in Table 44 can, therefore, be compared and assessed despite the differences in

Table 44. **Comparison of Estimated Income Elasticities of Food Demand By Chinese Rural Households, Mainland China**

Item	Halbrendt, et at. (1994)	Fan, et al. (1995)	Huang and Rozelle (1994)	Lewis and Andrews (1989)
Region	Guangdong Province	National	Zhejian Province	National
Data	2560 households 1990	Provincial data 1982-1990	259 households 1992	Provincial data 1982-1985
Model	LA/AIDS	Two-Stage LES-AIDS	LA/AIDS	LES
Commodity Coverage	Food and nonfood	Seven foods and nonfood	Four rices, four foods, and nonfood	Four foods, total food and nonfood
<u>Income (Total Expenditure) Elasticities</u>				
Food		0.707		0.69
Grains	0.575			0.15
Rice		0.496	0.140	
Indica			-0.116	
Japonica			0.138	
Hybrid			0.099	
Other Rice			0.102	
Wheat		0.771		
Coarse Grains		0.263		
Meats	1.092	0.898	0.046	
Pork				0.70
Poultry	1.273			1.35
Fruits	1.841		0.228	
Vegetables	0.911	0.668	0.337	
Sweets	1.193			
Fish				2.52

model specification and coverage of food items. First, at the aggregate level, the income elasticity for food was estimated to be 0.70 (from two studies). However, for aggregate food grain, the range is from 0.15 to 0.575. As for individual grains, the ranges of estimated income elasticities are very large. For example, the income elasticity of rice is 0.496 estimated by Fan et al. but only 0.140 by Huang and Rozelle. Of course, the variation of these estimates may be attributed to differences in model and data. Whether or not the true income elasticity of food or grain was observable when farmers supplied most of what they consumed, remains an unresolved issue. One interesting observation is that most estimates imply that grains remain a normal good for Chinese rural consumers. The only exception is Indica rice which Huang and Rozelle found to be an inferior food.

How about the income elasticities of nonstaple foods for rural households? The estimates all show that the income elasticities of nonstaple foods are generally higher than those of staple foods. However, it is not all clear cut whether the demand for nonstaple food is income elastic or not. For example, the estimated income elasticity of meats range from 0.046 (by Huang and Rozelle) to 1.092 (by Halbrendt, et al.), while the estimate of 0.898 (by Fan, et al.) lies in the middle. For pork, the most important meat in China, the only estimate is 0.70, showing pork as a necessity good. On the other hand, two estimates available for poultry all indicate that it is a luxury good. It is interesting to note that despite the steadily declining trend of the consumption of vegetables, its estimated income elasticities all have a positive sign, with the magnitudes ranging from 0.337 to 0.911, indicating it is not an inferior good.

What can we conclude from these elasticity estimates? If we are willing to assume that the consumption of self-supplied food indeed reflects valid rational consumption behavior consistent with utility maximization under budget constraint, then the available estimates at least suggest that grain is a normal good and the demand for nonstaple foods has strong income effects. Therefore, as rural households increase their income in the future as expected, they would continue to increase their grain consumption and would greatly increase their consumption of nonstaple foods including vegetable but particularly poultry.

We will now turn to urban households. Table 45 presents the estimated income elasticities for food and food products from four recent studies. Among these studies, only Chern and Wang (1994) specifically dealt with the effects of rationing. They estimated and compared two models, treating grain and edible oil as rationed vs. nonrationed goods. Despite the differences in model specification and coverage of food items, the income elasticities reported here are all defined with respect to total living expenditures of food and nonfood (or income). In cases, where the expenditure elasticities were first estimated in a model with only food or selected foods, these elasticities were converted to income elasticities by using a separately estimated income elasticity of total food expenditure.

The available estimates show that the income elasticity of total food ranges from 0.76 to 1.003. The latter estimate was obtained by Chern and Wang, based on the aggregate Engel function. In addition to their estimate of a nearly unitary income elasticity of food, they also obtained an estimate of marginal budget share of food to be 0.45. This figure would imply that as Chinese urban households increase their income by one yuan, they would spend 0.45 yuan for food. However, if their income increases by 1.0%, their food consumption (or expenditure) would increase by 1.0%. Since the Engel coefficient (i.e., the proportion of income spent for food) of Chinese urban households has remained fairly constant (between 51.4% to 54.5%) during 1985-1990, these estimates of marginal budget share and food income elasticity appear to be plausible.

With respect to staple food, the estimated income elasticities of grains (aggregate or wheat and rice separately) all have a negative sign. Under the assumption of no rationing effects, these results imply that food grain is an inferior good for Chinese urban households. We must be cautious about this conclusion because, as mentioned earlier, grain rationing was likely to distort the estimation of the "true demand relationship" from observed quantity and price data. We will further validate these results later.

The estimated income elasticities of edible oil are all positive and close to 0.40, indicating the necessity nature of this staple food. Since edible oil was also under rationing during the study periods, the effects of rationing on these estimates are uncertain.

In order to assess the validity of the estimated income elasticities for nonstaple foods, we must understand the potential effects of food rationing on the estimated demand parameters for nonrational foods. Tobin and Houthakker (1951) investigated the effects of rationing on demand elasticities. Their theoretical results show that the income elasticity of the demand for a good (as a substitute for the rationed food) will be larger during the rationing period than in a free market. For a complement of the rationed good, its income elasticity would be reduced during the rationing period as compared to a free market. That is to say, during the period of rationing, the income elasticity of a nonrationed food may be overestimated (for a substitute) or underestimated (for a complement). The problem in applying Tobin and Houthakker's theoretical results is that we do not know which nonstaple foods are substitutes or complements to the rationed grain and oil in Mainland China. However, based on their results, the empirical estimates of the income elasticities of (nonrationed) nonstaple foods are likely to be either underestimated or overestimated unless the rationing effects are incorporated into model specification.

Keeping in mind the above cautioning note, what is the evidence of income effects for nonstaple food in urban China? Chern and Wang show strong income effects for most nonstaple foods such as pork, poultry, fish and shrimp. He's estimates also show very high income elasticities (greater than unity) for pork, poultry and fruits in the coastal region. On the other hand, Wu et al. show relatively low income elasticities (smaller than 0.5) for most nonstaple foods.

Table 45 also shows the comparison of the two sets of estimates obtained by Chern and Wang. It is interesting to note that the estimated income elasticities of staple foods in the model treating grain and oil as rationed goods are lower than those obtained from the model considering grain and oil as nonrationed goods. If these nonstaple foods are substitutes to grain and oil as might be expected, these results confirm the theoretical findings of Tobin and Houthakker. That is, if rationing is not incorporated in the model specification, the income elasticities of nonrationed goods may be overestimated. It is also noted that the income elasticity of beef and mutton was shown to be negative in one of the models estimated by Chern and Wang. This problem often happened due to the fact that beef tended to be produced and thus consumed more in lower income in-land provinces. The true income effect may not be revealed in these provincial-level data.

In general, these available estimates of income elasticities of nonstaple foods are mixed

Table 45. **Comparison of Estimated Income Elasticities of Food Demand by Chinese Urban Households, Mainland, China**

Item	Chern and Wang[a] (1994)		He (1995)	Wu et al. (1995)	Lewis and Andrews (1989)
Region	National		Shandong, Jiangsu, Fujian, Guangdong	National	National
Data	Provincial data 1985-1990		Provincial data 1985-1991	33 cities 1990	By income group 1982-1985
Model	QES		Rotterdam	LA/AIDS	LES
Commodity Coverage	10 foods, total food and nonfood		10 foods	Six foods	Food and nonfood
Income Elasticities					
Food	1.003[b]				0.76
10 Foods	1.047[b]				
Grains		(-0.06)			
Edible Oil		(0.43)	0.34		
Vegetables	0.36	(0.47)	0.36	0.45	
Dried Vegetables	1.08	(1.15)			
Pork	1.42	(1.23)	2.25	0.44	
Beef and Mutton	-0.89	(0.61)	0.19		
Poultry	2.31	(2.76)	1.06		
Eggs	0.64	(1.17)	0.19	0.21	
Fish and Shrimp	1.86	(2.85)	0.34	0.08	
Fruits	0.88	(1.58)	1.68	0.55	
Wheat			-0.39		
Rice			-0.04	0.37	

[a]The estimated elasticities in parentheses are the estimates obtained from the model treating grains and edible oils as nonrationed goods.
[b]Estimated from Engel function (not the demand system).

and variable. However, the estimates obtained from Chern and Wang may be somewhat more credible because of their treatment of food rationing. Using their results, one may conclude that the income effects were very strong for such nonstaple foods as pork and poultry which require feed grains to produce. Due to the high variation of these estimates we will attempt to further evaluate the income effects using more recent data.

Additional Evidence

Food rationing was lifted in May 1993. Therefore, the year 1994 provided the first opportunity to observe food consumption without rationing effects. A demand function estimated with 1994 data alone should reflect consumption behavior under free market situation. Accordingly, we estimated several food demand functions using 1994 data from 28 cities and provinces. For comparison, the same functions were also estimated for 1992-1994. These regressions were based on unpublished urban household survey data obtained from the SSB. Since we were interested in income elasticities, a single-equation double-log model was used. The total living expenditure was used as the income variable Three sets of demand function were estimated -- total grain, rice and flour, and the meat group.

Table 46 presents the regression results for grain using ordinary least squares (OLS). Using only 1994 data, the estimated income elasticity is -0.064 and statistically insignificant. Furthermore, the price elasticities are also statistically insignificant but the own-price elasticity has a correct sign. The R^2 is 0.57. Expanding the sample size to include 1992 and 1993, produced worse results in terms of the statistical significance of estimated price elasticities and R^2. These results once again confirm the earlier finding of distortion in estimating the income elasticity of grain during the period of grain rationing.

Table 47 shows the OLS estimates of demand elasticities for rice and flour. In general, R^2 's are higher than those obtained for total grain because of the significance of own-price and cross-price elasticities. Expanding the sample size to include 1992 and 1993 lowers R^2 for rice but raises R^2 slightly for flour. It is important to know the magnitudes of

Table 46. Estimated Log-Log demand Function for Grain, Mainland China[a]

Period	Intercept	Grain Price	Pork Price	Vegetable Price	Income	R^2
1994	6.46	-0.726	(-0.391)	0.274	-0.064	
	(3.04)	(-1.61)	(-1.29)	(1.38)	(-0.26)	0.57
1992-94	5.361	-0.076	-0.190	0.002	-0.043	
	(3.93)	(-0.50)	(-1.03)	(0.01)	(-0.27)	0.21

[a]The figures in parentheses are estimated t-ratios.

Table 47. Estimated Log-Log Demand Functions for Rice and Flour, Mainland China[a]

Product	Period	Intercept	Rice Price	Flour Price	Income	R^2
Rice	1994	3.837	-3.536	1.167	0.198	0.65
		(1.01)	(-4.94)	(4.14)	(0.38)	
	1992-94	0.746	-1.205	0.931	0.384	0.49
		(0.30)	(-6.24)	(5.21)	(1.12)	
Flour	1994	-3.323	3.626	-3.453	0.815	
		(-0.39)	(2.27)	(-5.49)	(1.52)	0.75
	1992-94	-2.140	2.085	-3.315	0.815	
		(-0.54)	(6.87)	(-11.8)	(1.52)	0.75

[a]The figures in parentheses are estimated t-ratios.

price elasticities in absolute value are all higher when they were estimated with 1994 data alone. These results may also suggest that the estimates were less distorted when we used only 1994 data. The own-price elasticities in absolute value exceed 3.0 in both cases, suggesting a strong price effect for rice and flour. With respect to income elasticity, the estimates are all statistically insignificant although they all have a positive sign. The estimated income elasticity for flour is higher than that for rice.

Table 48 presents the OLS results for pork, beef and poultry. In terms of the overall fit, adding data from 1992-93 did not help much for pork and beef but significantly lowered R^2 for poultry. Another interesting observation is that all elasticities (in absolute value) are higher when they were estimated with only 1994 data except for the elasticities of poultry price and income in the pork demand function. The poultry equation has the best fit with a R^2 of 0.67, using 1994 data. The estimated income elasticity of 2.51 for poultry is almost identical to 2.31 estimated by Chern and Wang, using similar data from 1985 to 1990. The results reveal further that poultry demand has the highest income elasticity, followed by pork (0.923) and the beef (0.631). The estimate for beef still has a very high standard error.

Overall, these results suggest that the true demand elasticities of grain for Chinese urban consumers have become more observable from market data after the elimination of grain rationing in 1993. While the recent data provide fairly significant estimates of own-price and cross-price elasticities for rice and flour, the estimated income elasticities for grain, rice and flour remain statistically insignificant. We may still need more data after the elimination of rationing in order to more accurately estimate these income elasticities.

Table 48. Estimated Log-Log Demand Functions for Meats, Mainland China[a]

Meat	Period	Intercept	Pork Price	Beef Price	Poultry Price	Income	R^2
Pork	1994	-2.185	-0.284	-0.972	0.246	0.923	0.34
		(-0.84)	(-0.28)	(1.45)	(0.21)	(1.91)	
	1992-94	-3.143	0.017	-0.968	-0.419	1.158	0.31
		(-2.51)	(0.05)	(-3.68)	(-1.14)	(5.02)	
Beef	1994	-2.206	1.923	-1.719	-1.075	0.631	0.12
		(0.53)	(1.19)	(-1.61)	(-0.59)	(0.81)	
	1992-94	0.523	0.774	-1.628	0.461	0.129	0.21
		(0.29)	(1.59)	(-4.34)	(0.88)	(0.39)	
Poultry	1994	-15.306	2.687	-1.385	-2.448	2.514	0.67
		(-5.29)	(2.41)	(-1.87)	(-1.96)	(4.67)	
	1992-94	-10.448	1.824	-1.351	-2.196	2.089	0.52
		(-6.18)	(3.96)	(-3.79)	(-4.42)	(6.69)	

[a]The figures in parentheses are estimated t-ratios.

With respect to meats, the results provide strong evidence of income effects, especially poultry and pork. As income increases, Chinese urban households will consume considerably more poultry, substantially more pork, and also more beef as well.

Validation of Grain Deficit Prediction

This paper attempts to assess the validity of the demand side projection of the grain deficit equation used by Brown and Perkins. On the demand side, the major factors identified are the income effects shifting the food consumption pattern from grain staple to animal products.

The trends of per capita consumption of staple and nonstaple foods by Chinese rural households do not show clear-out income effects. It is true the yearly fluctuations of food consumption were affected by changes in relative prices. The high self-sufficiency ratios for most food consumed by rural households may pose difficulty in observing the true consumption behavior. Even though the trends of per capita consumption of staple and nonstaple food for Chinese urban households exhibit a more notable association with income, the effects of rationing on the observed consumption are difficult to sort out in these descriptive statistics. Only one thing is very certain from the observed historical trends and that is urban households consumed considerably more meats, eggs, poultry, oil, and sugar but much less grains than rural households. Therefore, as the migration from rural to urban areas continues into the future, there will be increasing demand for meats and decreasing demand for food grain. These predicted trends certainly are in agreement with the assessments of both Brown and Perkins.

As analyzed previously, the available estimates of the income elasticities of staple and nonstaple foods show mixed results in both rural and urban areas. However, the major differences among these estimates lie in the magnitudes and not the sign except for grain. Whether or not grain is an inferior good remains unresolved. It is useful to gain further insights by analyzing low quality vs. high quality grains as done by Huang and Rozelle (1994). Their results show Chinese rural households have consumed more high quality rice such Japonica and less low quality rice such as Indica. However, their estimates of income elasticities for high quality rices are still very low (less than 0.14). The problems of self-sufficiency of grain in rural areas, and grain rationing in urban areas must have affected our ability to identify the true income elasticity from the observed data. Our attempt to estimate the income elasticities of grain using only 1994 data from SSB's urban household survey yields only mixed results. Total grain was found to be an inferior good while the demands for rice and flour have positive income elasticities. But these estimates have very high standard errors, making them statistically insignificant.

With respect to animal products, the available estimates of income elasticities are also mixed in terms of magnitudes. In particular, the estimated income elasticities of meat and pork demands varied substantially, making it uncertain whether or not it is a necessity or a luxury good in the Chinese diet in both rural and urban areas. The estimated income elasticities for beef were fairly unsettled due to the problem of supply availability mentioned earlier. On the other hand, the estimated income elasticities for poultry were fairly robust, pointing to a very strong income effect. Our regression results using 1994 urban household survey data validate these findings.

Overall, these estimates of income elasticities appear to support the hypotheses used by Brown and Perkins in their predictions. Of course, we can not validate their predicted magnitudes without carefully incorporating these estimates in a forecasting model with both demand and supply and conducting adequate sensitivity analysis. On the surface though, the only clear-cut strong income effect was found in the demand for poultry. It would be hard to imagine such a high grain deficit as predicted by Brown can occur simply by the drastic increases in the demand for poultry, which after all, requires much less feed grain to produce than pork. One must admit that the year 2030 may be too far away to make any accurate prediction especially under rapidly changing food consumption patterns as observed in recent years.

Chapter 6

Conclusions

This is the final report for the second-year project. This report presents several research tasks completed during this year. One major task completed dealt with the econometric estimation of supply response and food demand using both the rural and urban household survey data in four provinces (including Guangdong).

Based on the recent trends of supply-demand balances for selected key agricultural commodities, constructed by this study, the coastal region has demonstrated its ability to expand its surpluses of pork, eggs, aquatic products and poultry. However, for food grains including rice, the recent trend of surpluses indicate a weak potential for further export expansion. Unfortunately, we do not have sufficient data to analyze the trends for specialty crops such as peanuts or garlic.

In our econometric analysis, we separated the coastal region into the North (Shandong and Jiangsu) and the South (Fuijing and Guangdong). With respect to supply response, we estimated both acreage and output functions for major crops and livestock products. The results show that the output of grain in the northern coastal region is affected by its price but not so in the southern region. Furthermore grain acreage was found to be unresponsive to price. Therefore, any further increase in grain output has to rely on increases in yield which has a limit in the long run. On the other hand, since the acreage of oil-bearing crops was found to be responsive to its own-price and the price of competing cash crops, there will be potential for acreage expansion if the price of oil-bearing crops increases relative to its competing cash crops. Our econometric results also found that the rapid development of rural industry had negative effects on the growing acreage of vegetables.

As for livestock products, we found that pork supply is highly price responsive in the whole coastal region. Also, fresh egg output is very price elastic in the North and poultry output is very price elastic in the South. These specific estimates may reflect the particular patterns of consumption, i.e., the North consumed more eggs and less poultry than the South. These estimated price elasticities would suggest potential for supply expansion if the prices of eggs and poultry increase in the future. The same would also hold for pork.

Our econometric results of food demand show that the marginal budget shares of wheat and rice are negative, implying that the are becoming inferior goods in the urban areas of the coastal region. Pork, fresh fruits, and poultry has the largest expenditure elasticities. Also, wheat, edible oil, fresh egg, fish and shrimp, and poultry are found to be highly price elastic. Thus, their future demand is highly dependent upon the price levels of these products.

This report also documents our analysis of several recent important events which we believe will affect the formation of policies and strategies for agricultural development in Mainland China. The recent debates on "how to feed the 1.2 billion people" underlined the increasing concerns by Chinese leaders about the possible grain deficit in the future. Under the country's overriding objective of self-sufficiency in food, Mainland China will unlikely pursue any aggressive strategy to expand its agricultural exports. However, in many provinces especially those in the coastal region, the agricultural export has been an important component of their economic development strategies.

In order to validate Brown's prediction of Mainland China's future grain imports, we undertake a careful assessment of recent food consumption trends and available evidence of the income effects of Mainland China's food demand. It was evident that urban households consumed much more animal products such as meats, poultry, and eggs but much less grain than rural households. Furthermore, the urban demands for meats and poultry have higher income elasticities than rural demand. As the migration from rural to urban areas continues and household income raises further in the future, one can expect China's demand for food grain will decline while its demand for feed grain will increase. The evidence of income effects would support the hypotheses used by Brown and Perkins in their predictions. However, whether the growing grain deficit would reach 305 millions tons by 2030 or 40 million tons by 2000 can not be verified or supported by the available estimates of the income elasticities of food and food products.

The results suggest the growing future demand may be expected for such food as poultry, fish, and to a lesser extent, pork. Even though they are not assessed in this paper, the demands for milk and other processed foods are likely to have high income effects also. The growing consumer demand will provide a market signal for farmers to respond. Without any doubt, the Chinese agricultural sector will undergo drastic changes in the future to meet this changing pattern of food consumption behavior.

In order to systematically validate Brown's prediction and to consider other factors affecting Mainland China's agricultural sector, we will need a structured forecasting model. Our efforts during the next (third) year will focus on developing such a forecasting model which will incorporate both demand and supply for policy and sensitivity analyses.

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